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Team Training and Performance Research: A Ten-Year Review

Clint A. Bowers, Jeanne L. Weaver, Julie M. Urban, and Ben B. Morgan, Jr.
University of Central Florida

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The military has become dependent upon the performance of teams for many critical tasks. Consequently, there is a clear need to understand the nature of team performance to develop training interventions for use in ensuring effective military teams. Unfortunately, the scientific literature regarding team performance has provided little guidance regarding the nature of team performance or the most efficacious paradigms for team training. Since Dyer's review (1984) 10 years ago, interest in team training and performance has greatly increased. The current effort discusses issues raised by Dyer in light of the past 10 years of research and remaining research needs in these critical areas.

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TEAM TRAINING AND PERFORMANCE RESEARCH: A TEN-YEAR REVIEW

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TEAM TRAINING AND PERFORMANCE RESEARCH: A TEN-YEAR REVIEW

The military has become dependent upon the performance of teams for many critical tasks. However, a variety of mishaps have converged to demonstrate that effective team performance is not an "automatic" occurrence. Rather, it seems that effective teamwork is a consequence of a complex developmental process. In order to ensure effective operational performance, it is necessary to accelerate this process so that effective team performance results as quickly as possible. Consequently, there is a clear need to understand the nature of team performance in order to develop training interventions for use in ensuring effective military teams.

Unfortunately, the scientific literature regarding team performance has provided little guidance concerning the nature of team performance or the most efficacious paradigms for team training. Ten years ago, a review of the literature by Dyer (1984) indicated several important research needs in the areas of training and team performance. Since the publication of Dyer's review, however, there has been a greatly increased interest in these issues by both basic and applied researchers. Much of this research has been sponsored by, and directed toward, the military. There is now a solid body of knowledge that

has accumulated in the last ten years. There are also significant efforts currently underway to improve our understanding of teams, groups and collectives. Towards this end, this review revisits the questions that Dyer (1984) addressed by Dyer (1984) in summarizing the research needs of a decade ago. Specifically, each of the questions raised by Dyer will be discussed in light of the past 10 years of research, and currently remaining research needs will be highlighted for each of these critical areas of research. Thus, the remainder of this report is organized around the framework of Dyer's (1984) six questions.

What are the unique features of teams?

Sundstrom (1990) notes that the 1980's produced a renewed interest in the role and benefit of teams beyond their use in sports and the military, and that self-regulating work teams have become major "building blocks" of organizations. Several reasons have been noted for the increased use of teams in industry (Cannon-Bowers, Oser, & Flanagan, 1992). First, there are many modern tasks which simply cannot be performed by a single individual. Second, in many circumstances, teams clearly outperform an individual. Finally, the humanistic movement in management theory has contributed to the belief that workers should take meaningful roles in the operation of their organizations through the formation of work related teams.

It is also important to note that because many teams are required to perform in stressful and/or complex environments, it is becomingly increasingly critical for researchers and practitioners to fully understand the multifaceted nature of teams and their performance.

Two primary concerns of Dyer's (1984) review, which covered the period from 1955 to 1980, were the attainment of a useful definition of a team and the derivation of a comprehensive, theoretical description of team behavior. In fact, one of Dyer's original questions was "what are the unique features of teams?" This question demands answers in regard to the defining characteristics of "team" and related descriptive models of teams and their performance. Understanding of such issues is critical in order to allow researchers and practitioners to determine the extent to which particular research conclusions might apply to various types of teams or groups. In turn, this understanding will facilitate the design of optimal strategies for team training.

This section will address progress made on both of these issues since the time of Dyer's review by providing an overview of current team definitions and models in order to determine the progress made and to identify particular areas in need of further research and reflection. First, we will discuss and review team definitions and propose a change in

focus for conceptualizing the definitions of team and group. Our response to the next question will examine some of the most salient theoretical approaches to understanding teams and discuss the role that theory can play in advancing our knowledge of team process and performance.

Team Definitions. As noted by Dyer (1984), the establishment of a meaningful definition of the team construct is not a trivial issue. Like any other topic investigated in psychological research, it is important to arrive at an acceptable definition of the construct in order to facilitate communication among interested researchers and promote sound research. It is apparent that team/group researchers, as a whole, have at times been in disagreement regarding the construct over the past decade. In fact, the small group literature and team literature have often been viewed as completely unrelated to one another. Although some portion of the group literature is primarily concerned with non-task performing groups, the literature in large part *is* relevant for work groups. The lack of collaboration between such group and team researchers is problematic, in part, because the "occupational" groups of people to whom results are to be generalized are often similar (e.g., military, surgical, and organizational teams). Therefore, care should be taken to determine the nature of the characteristics which define the types of groups

investigated in current research and to define them appropriately.

In the past, a primary concern of some team researchers and practitioners interested in "real world" settings has been the extent to which the small group research can be considered relevant for psychologists interested in the performance and processes of operational teams (Driskell & Salas, 1992). It has been argued that group research has little relevance for a number of reasons. For example, Modrick (1986) noted that in the typical small group study, there are no prior interactions between group members, the study's duration is brief, the group tasks to be performed are relatively simplistic, and the outcomes have little impact on the group's members. Orasanu and Salas (1993) make a clear and deliberate distinction between teams and groups. These authors argue that teams can and should be distinguished from groups because team members are highly differentiated and interdependent while group members are homogenous and interchangeable.

Orasanu and Salas (1993) argue that a critical characteristic of teams is that their members are interdependent. However, Cartwright and Zander (1968) define a *group* as "a collection of individuals who have relation to one another that make them interdependent to some significant degree." Thus, although team researchers argue

that the distinction between groups and teams is a lack of necessary interaction among members, it has been argued that, a group does not exist unless some interdependence is present among its members.

On the other hand, some researchers refrain from making any distinction between teams and groups. For example, Sundstrom and his colleagues note that "the terms work team and work group appear often in today's discussions of organizations" and "far from [teams] being revolutionary, work groups are traditional" (Sundstrom, 1990, p120). In a similar fashion, Gersick states that "groups are essential management tools. Organizations use teams to put novel combinations of people to work on novel problems and use committees to deal with especially critical decisions" (Gersick, 1988, p. 9). Thus, these researchers use the terms group and team interchangeably. Finally, it is also often the case that no formal definition of teams/groups is offered within the publications of team researchers.

Although the actual definition of team has been at times unclear, there are actually similarities across much of the literature (Modrick, 1986; Sundstrom, 1990). Table 1 depicts several definitions offered by team researchers. The following definition encompasses the essential characteristics of a "team" or task-performing group and is offered as representative of such definitions. A team is

defined as "a distinguishable set of two or more individuals who interact interdependently and adaptively to achieve specified, shared, and valued objectives" (Morgan, Glickman, Woodard, Blaiwes, & Salas, 1986, p. 3).

It has been argued (Salas, Dickinson, Converse, & Tannenbaum, 1992) and it is the contention of the current authors that teams can and should be conceptualized as lying along a continuum of interdependence. That is, rather than considering teams and groups as dichotomous, they should instead be seen as points along the same continuum. Indeed, Driskell and Salas (1992) have responded to criticisms of the small group research with a plea that this body of research be recognized for its contribution to the generation and testing of theory. These authors offer the argument that although small group research has been criticized for being a) too artificial, b) not generalizable, c) too abstract, and d) commonsensical, it serves a valuable purpose and continues to contribute to the knowledge base regarding groups and teams. Although the research issues which need to be addressed at points along the team/group continuum may differ in relative criticality, it should be acknowledged that the constructs are not orthogonal.

It is the contention of the current authors that the definition offered by Morgan and his colleagues is relevant

for discussions of most operational/organizational teams. If researchers are willing to accept this definition of team as a point of departure, attention can then be directed toward what we consider to be one of the most critical factors in arriving at an understanding of the processes and performance of task-performing teams: interdependence. As with any other psychological construct, it is suggested that researchers clearly define the constructs they intend to discuss. In this particular case, most teams and groups found in operational/organizational settings will be well described by the definition of Morgan et al. (1986). However, it may be important for researchers to describe additional defining characteristics of the particular teams in their study. This would provide enough information to determine the extent to which results might generalize to particular types of groups/teams. One factor that might be particularly useful in this regard is an expanded discussion of the degree of member interdependence. Research over the past decade suggests that interdependence is a critical determining factor of the degree to which teams/groups share similarity across tasks and environments and that research will be facilitated by using this construct as a common referent. Toward that end, a discussion of the nature and measurement of interdependence is provided below.

Interdependence

Saavedra and his associates (Saavedra, Earley, & Van-Dyne, 1993) discuss a model of work group performance which is based on what they describe as "complex interdependence." Complex interdependence is used to describe the interaction of three types of interdependence: task, goal, and feedback interdependence. Task interdependence is the degree to which group members are required to rely on their teammates for the performance of their jobs. Goal interdependence refers to the nature of the performance objectives. That is, the extent to which objectives for performance outcomes are geared to individuals or the group. Similarly, feedback interdependence refers to the provision of feedback for group members or the group as a whole.

The authors argue that because of the three-dimensional nature of this construct, predictions regarding a group's processes and performance based on this model will vary from predictions based on any one of these dimensions in isolation. Because interdependence can vary on a number of dimensions, these authors are concerned with the extent to which compatibility or congruence of the dimensions might be associated with optimization of group process and outcomes. While the model appears to have some utility in this regard, it might also serve as a method of describing the interrelationships among team members more accurately. That

is, this conceptualization of interdependence might serve to better explicate the nature of the interdependence construct which is an integral component of the definition of "team." In order to evaluate this possibility, the discussion which follows will describe each of the dimensions of complex interdependence in detail, beginning with task interdependence.

Task Interdependence. Task interdependence has been defined as the relationship among group members' tasks or the extent to which members of groups are reliant on one another to perform their tasks given a particular job design (Saavedra, et al., 1993). This definition is based on the earlier work of Georgopoulos (1986), Kiggundu (1981;1983) and Van de Ven and Ferry (1980). It is interesting to note that Saavedra and his colleagues describe interdependence in the context of "task performing *groups*."

The task interdependence paradigm described by Saavedra and his associates (1993) is based upon the earlier work of Thompson (1967) and Van de Ven, Delbecq, and Koenig (1976). This paradigm outlines a hierarchy which describes four levels of task interdependence, each of which is increasingly dependent and necessitates greater coordination among team members. This hierarchy of task interdependence is related to the exchange of resources and information of a team's members at the lowest level of interdependence is the

pooled interdependence level, where each member contributes to the output of the group, but without a requirement for interaction among the members of the group. Saavedra and his colleagues note that the members of the group share similar roles but each individual member completes their entire task. At this level of interdependence "group performance is the sum of individual performances." An example of pooled interdependence might be a group of attorneys assigned to personal injury cases within a law firm. Their group performance might be total income earned for a particular period of time.

The next level of interdependence in the hierarchy is sequential interdependence (Saavedra et al., 1993). Sequential interdependence requires group members to act one after the other. In this level there is a one-way flow of work with each member completing a portion of the whole task which differs from that of the other members. In addition, the contributions of each of the members must be completed in a particular order. One of the most obvious examples of this level of interdependence is work on an assembly line (Saavedra et al., 1993).

The third level of task interdependence is reciprocal interdependence. This level differs from sequential interdependence in that the flow of work is two way. That is, the output of one member becomes the input of any other

member. Saavedra notes that members under this level of interdependence are typically experts in their different roles and that these different roles are performed in a flexible order. However, it is important to note that while the order is flexible, the structure of the members roles are externally imposed and coordination among group members is required. An example of interdependence at this level might be command and control teams. In a command information center (CIC) individual team members are required to acquire and assimilate information in order to determine the nature of targets in the environment. Because this environment is dynamic and uncertain there is a demand for team members to continuously monitor the environment and coordinate their actions accordingly.

The final level of task interdependence is team interdependence. This level of task interdependence is characterized by mutual interactions of group members. However, unlike reciprocal interdependence, a group functioning under team interdependence has the freedom to design their jobs. That is, whereas member roles of reciprocal interdependence teams are determined by the environment, under this level of interdependence members determine the flow of their inputs and outputs across members. These group members coordinate their actions to solve problems and complete their tasks. The example

offered by Saavedra and his colleagues is the self-managed work team. In this instance, a creative group might be required to design a new product, implement its creation and see the product through to its actual sale. The members of the group would determine the roles of the members and the tasks required by each in order to accomplish their goals.

These four levels of task interdependence are useful in that they provide a method for conceptualizing the nature and extent of interactions and coordination required by particular tasks. Thus, researchers are provided with a common referent for discussions of team and group process and performance. By noting which level of interdependence is demanded by the study of interest, other researchers and practitioners are made cognizant of the extent to which they might generalize to their own program of research or organizational setting.

Saavedra and colleagues (1993) manipulated levels of task interdependence. That is, these researchers designed tasks which required team members to interact in the manner described by each level of task interdependence. For example, team members under sequential task interdependence were instructed to use a unidirectional flow of work. For researchers interested in investigating the relationship of task interdependence to other variables, task interdependence of existing teams can be assessed via the

Work Flow Interdependence Index (Thompson, 1967) and the Mohr Task Interdependence Index (Mohr, 1971), which assess perceived interdependence from the supervisor's and team member's points of view, respectively. Thus, investigations of task interdependence can be carried out with task interdependence as either a manipulated or measured variable.

Goal Interdependence. The second component of complex interdependence as discussed by Saavedra and his associates (1993) is goal interdependence. Goal interdependence is defined as "the interconnections among group members implied by the type of goal (individual or group) that guides their performance" (Saavedra et al., 1993). It has been argued that goal setting acts on performance by indicating task strategies and motivating persons to perform (Mitchell & Silver, 1990). Because goals act by guiding available resources toward a particular strategy, changing the focus of goals, in turn, alters the direction of actions taken. That is, goals which are oriented toward the actions of the individual influence individual task performance, while goals oriented toward the group impact the group's performance. Thus, the rationale behind the consideration of goal interdependence is that goals must be consistent with the outcomes desired. For example, a task in which the level of task interdependence is high would likely be

inhibited by individual goals in the sense that individual task performance would be emphasized. On the other hand, group performance would likely be facilitated by group goals. The effects of group goals were investigated by Matsui, Kakuyama, and Onglatco (1987). Results indicated both greater goal acceptance and better performance of group goal subjects than individual goal subjects in spite of equal ability levels. However, the individual goals set by group and individual goal condition subjects did not differ. The authors suggest that productivity would be increased by having employees work as teams with team goals rather than as individuals with individual goals.

Feedback Interdependence. The final component of complex interdependence is feedback interdependence. Feedback interdependence refers to the interconnections among group members which occur as a result of the performance feedback given (Saavedra et al., 1993). Feedback may be given regarding the individual tasks group members perform or in relation to the task the group is performing as a whole. In the latter case, feedback regarding the activities of the individuals is not discernible. Instead, group feedback presents information regarding the strategy implementation and coordination of the group. Individual feedback, on the other hand, provides

information regarding group members own tasks without reference to the performance of the group.

Feedback interdependence, like goal interdependence, should be provided to team members in a manner which is consistent with the outcomes desired. That is, feedback should be congruent with the goals which are set. Although it has been argued that goals must be accompanied by feedback in order to be effective (Matsui et al., 1987), Watson (1990) has suggested that feedback might not be as critical for team performance as it has been shown to be in past research regarding individuals (Locke, Shaw, Saari, & Latham, 1981). Watson concluded in her discussion that "what is new in these results is the idea that goals are more important for energizing a group than feedback, that they encourage a more receptive attitude toward feedback, and that they can motivate group members even when feedback is unavailable" (Watson, 1990 p. 88). It is evident that there is a need to investigate further the relationships among goals, feedback, and group performance in order to determine the relative importance of goals and feedback on the team's performance.

The hypothesized mechanism by which the feedback and goal interdependence dimensions function is related to the *congruence* between the dimensions. That is, it is the contention of Saavedra and his colleagues (1993) that goals

and feedback will have the greatest utility when presented in a congruent fashion because coordination among members is thereby facilitated. For example, they argue that feedback presented to individuals in the context of a group goal might result in conflict within the group due to individuals being singled out for blame due to less than adequate performance. This incongruence might also lead to strategies of competition rather than cooperation. Neale and Bazerman (1991) argue that tasks which signal both competition and cooperation, mixed motive tasks, may engender conflict and lead to lost time because of increased demand for negotiation and conflict resolution. In contrast, a congruent constellation of task, goal, and feedback are argued to facilitate the potential for optimal group performance (Saavedra et al., 1993). McGrath (1984) notes that this congruence acts to clarify the performance setting and directs the efforts of group members.

It appears that Saavedra and colleagues' (1993) theory of complex interdependence, including task, goal, and feedback interdependence, based on the earlier work of Thompson (1967) and Van de Ven and colleagues (1976; 1980), provides a useful conceptualization of the construct. Complex interdependence theory gives a meaningful and usable breakdown to the interdependence construct to allow efficient communication among team researchers regarding the

types of teams they are addressing. That is, by providing both a definition (e.g., Morgan et al., 1986) and a referent in the form of the interdependence dimensions, team research might be facilitated by beginning to form a sort of taxonomy of team research findings. In other words, we would begin to develop an understanding of the types of issues which differentially impact teams of varying levels of interdependence.

This taxonomic approach can be illustrated by referring to the work of researchers at the University of Central Florida (Bowers, Urban, & Morgan, 1992; Urban, Bowers, Morgan, & Monday, 1993). These researchers have investigated the effects of team structure on team performance. The three structures investigated to date are non-hierarchical, hierarchical, and product structures. Structure was manipulated by varying the information and capabilities assigned to members of five member teams, performing a networked resource allocation task presented via personal computers. The task required the identification and prosecution of targets appearing on a simulated radar scope, by allocating resources on a per target basis. Within the non-hierarchical structure team members were assigned identical capabilities and information whereas, team members in the hierarchical structure were each assigned only the information and capabilities required

to allow them to perform specialized components of the team task (Bowers et al., 1992). In contrast, product structure team members had identical capabilities and information but were able to perform only in a limited geographic region which did not overlap with the regions of other team members.

By considering the definitions of the task interdependence levels described by Saavedra et al (1993), each of the structure levels manipulated by Bowers and his colleagues can be located in their appropriate level of task interdependence. That is, the non-hierarchical structure corresponds to the team task interdependence level, the hierarchical structure to the sequential task interdependence level, and the product structure to the pooled level of task interdependence. The non-hierarchical structure corresponds to the team level of task interdependence because team members "determine the flow of inputs and outputs across members." Hierarchically structured teams, as created for the purposes of these studies, are required to act in a serial fashion as described by Saavedra's sequential task interdependence level. Finally, product structured teams are likened to the pooled level of task interdependence because team members are required to perform in their own geographic location, thus minimizing interactions with other team members.

Figure 1 depicts a three-dimensional representation of Saavedra's model of complex interdependence with the three structure types appearing in their appropriate cells. As the figure shows, goals and feedback were constant across the three structure conditions. It should be noted however, that team performance varied across the three structures. Best performance was exhibited by non-hierarchical teams, followed by hierarchical teams and then by product structured teams. Thus, best team performance was achieved by the *team* interdependence level teams and worst by the *pooled* interdependence level teams. As predicted by the model, congruence among the implicit and explicit goals and feedback, and task interdependence was associated with superior performance. It might be argued that although product structured teams were told to maximize team score, the independent structure of their task was such that they might have perceived less teamness in this condition thus compromising their team performance.

By conceptualizing existing and future research within this paradigm we can begin to develop an increased awareness of where we have been and where we need to go in order to propel knowledge regarding team processes and their performance. That is, the conceptualization of team research in this way provides a taxonomic referent which gives direction for further research. By utilizing this

method of organizing or conceptualizing team research, researchers and practitioners will be better equipped to identify gaps in the literature with regard to areas most in need of additional research. Furthermore, by developing an awareness of the types of issues which most impact teams with different levels of complex interdependence, the development of training interventions might be facilitated.

Theories of Team Performance

In addition to stating concern regarding the definition of the team construct, Dyer (1984) also noted the lack of systematic development and testing of theories or models of team/group behavior. She argued that though some effort had been devoted to this task, past models had failed to adequately delineate hypothesized relationships among the variables included. It is the finding of the current review that progress in this regard has been made within the decade since Dyer's review. However, much of this progress has been in regard to the development of models, as opposed to the testing of the relationships described within them. Although the systematic investigation of these variables and their relationships has been conducted to a greater extent than had been the case at the time of Dyer's review, there is still a need for more investigations of this type.

The following sections will review the prominent models that have been developed in the last decade, discuss the

criticality of extending the development of these models into empirical tests of their utility, and finally, describe research which has been conducted in order to purposefully test existing theories. It is argued that substantial gains in knowledge regarding team/group processes and performance will be gained only when models are adopted, tested, and revised based upon empirical investigations of the variables described therein. In addition, by selecting and testing these models, issues regarding selection and training might also be elucidated. Therefore, the remainder of this section will discuss these issues related to the development and empirical investigation of theoretical approaches to the study of team processes and performance.

Although there are many models of team performance, in general, the models can be considered as either *developmental* or *descriptive* models. Only the latter type of models will be discussed within this section as developmental models will be discussed in a later section. Descriptive models of team performance typically adopt some derivative of an input-process-output approach to the study of team process and performance. In addition, these models typically attempt to describe factors which might act within each of the input, process, or outcome cells, in addition to describing environmental factors which might impinge upon

teams and thus have some impact upon their processes and/or performance.

Descriptive Models

In contrast to developmental models of team performance, descriptive models primarily provide a theoretical description of teams at any given point in time. That is, developmental models are temporally based, while descriptive models do not emphasize time but instead attempt to capture team dynamics by describing possible variables which might impact the team at any given point in time. Since the time of Dyer's review descriptive models have been developed by Kolodny and Kiggundu (1980), Hackman (1983), Gladstein (1984), and Tannenbaum, Beard, and Salas (1992).

Kolodny and Kiggundu's (1980) Sociotechnical Systems Model represents an attempt to describe an optimal fit between the social characteristics of organizations and technology. The components of the model include leadership and supervision, organizational arrangements, task conditions, and group characteristics. The leadership and supervision component feeds into organizational arrangements, which in turn feeds into the group interactions which occur as a result of the meeting of task conditions and group characteristics. These group interactions then lead to outcomes. Finally, the model depicts outcomes as acting as sources of feedback for

subsequent occasions by impacting other variables within the model, such as its effects on leadership and supervision. Thus, this model provides a valuable contribution in its depiction of factors related to teams and their performance.

Hackman's normative model (1983) includes components related to organizational context, group design, group synergy, process criteria and effectiveness, material resources, and group effectiveness. Organizational context is relevant in regard to the extent to which team members are supported and reinforced for their performance through rewards, education, and information. Group design refers to the extent to which the task is designed to prompt and facilitate optimal performance through task structure, group composition, and group norms. Both of these components are then moderated by the group's synergy. These are factors which either reduce process losses or result in process gains. The process criteria component then refers to the knowledge and skill brought to the task, the applied effort, and the appropriateness of the task performance strategies adopted by the team. The sufficiency of material resources are then brought into play and act to impact the final group effectiveness component. Group effectiveness is relevant in regard to the acceptability of the task output to those who review or receive it, the ability of group members to work

together on future endeavors, and satisfaction of the group members with the total experience.

Hackman's model appears to provide a useful *general* approach to the description of team performance. In fact, Hackman's model has been quite influential in shaping thinking regarding teams and their performance. His model appears to have motivated other scientists to explore the nature of team performance more fully. Thus, subsequent models of team performance have described related factors in more detail.

Gladstein's (1984) model of task group effectiveness is somewhat more inclusive in its attempt to describe factors which impact the performance of organizational groups. This model is a derivative of an input-process-output model with each of these components further defined. The input components as described by Gladstein are group composition and group structure (reflecting group level variables) and available resources and organizational structure (reflecting organizational level variables). Examples of group composition variables might be job tenure, heterogeneity, and skill adequacy, while group structure variables might be norms, size, and role clarity. Resources available might refer to training and markets served while organizational structure refers to supervisory control and group performance rewards.

Group processes include communication, conflict, team member supportiveness, and derivation of strategy. Process then feeds into group effectiveness, which is moderated by the group task. Measures of group effectiveness are performance and satisfaction, and task components are interdependence and complexity. Gladstein's model provides a somewhat more detailed depiction of the interrelationships of variables which might impact a team's performance. Like Hackman's model, Gladstein also includes a consideration of team members' satisfaction as an outcome of their shared interactions.

The final model to be discussed is the Team Effectiveness Model recently posited by Tannenbaum, Beard, and Salas (1993). This model provides an inclusive treatment of team inputs, process variables, and outputs. In addition, organizational and situational characteristics are also included. Input components described by the model are task characteristics, work characteristics, individual characteristics, and team characteristics. Task characteristics include variables such as task complexity, organization, and type. Task characteristics then feed into work characteristics and team characteristics. Work characteristics refer to work structure, team norms, and communication structure, while team characteristics refer to variables such as homogeneity of membership, power

distribution, and cohesiveness. Work characteristics are also offset by individual characteristics which include such variables as task knowledge, skills, and abilities (KSAs), motivation, and attitudes. Throughput components are team processes and training. Team processes include coordination, communication, and teamwork. As described by the model, team process is both preceded and followed by the impact of training. Training characteristics included by Tannenbaum and his colleagues are task analysis, training design, and learning principles.

Training is the final intersection depicted by the model before the output cell or team performance component. Measures of team performance include quality and quantity of performance, time, and errors committed. A feedback loop from this component back to team inputs is also included, indicating that a team's performance acts as a contributing factor to their subsequent performance sessions. It is recognized that all of the input-process-output components occur within a context determined by organizational and situational characteristics. These characteristics can be reward systems, uncertainty of environment, supervisory control, and resources available. Because of the comprehensive nature of the model described by Tannenbaum and his colleagues, it provides a meaningful contribution to research regarding teams and their performance. The

variables and their interrelationships depicted by the model provide a guideline for researchers with which to facilitate empirical study.

An important point to be recognized is that theoretical conceptualizations are critical to the acquisition of knowledge regarding variables which impact the performance of teams. This is the argument espoused by Lewin (Marrow, 1969). However, theory is meant to serve as a guide to research. Thus, it is important for researchers to maintain the orientation that theory and empirical study should proceed hand in hand. Theory without empirical tests does little or nothing to advance the accumulation of knowledge regarding the construct. That is, while there "is nothing more practical than a good theory" there is also nothing more practical than good practice. Researchers should ward against the temptation to derive new theories without first testing the utility of those which exist. It has been suggested (Knefelkamp, 1984) that scientific disciplines progress in cycles such that there are periods of theoretical emphasis followed by periods of empirical emphasis. Team research has experienced a state of "theoretical evolution" and it appears to be time to progress to a cycle of theory testing in order to maximize our knowledge. Given the criticality of teams in a variety

of environments, steady progress in the accumulation of understanding regarding the performance of teams is needed.

Although this might appear to be a somewhat trivial point, it deserves mention in order to encourage team researchers to test promising theories (e.g., the TEAM model, Team Effectiveness Model, etc.). The next section will discuss research purposefully conducted as tests of theory. When considering the amount of research currently being published in the team performance arena, it is surprising that more research of this type is not being conducted. Indeed, few efforts have been devoted to the systematic test of existing theories. The next section will describe a number of such studies. These investigations provide a useful illustration of this theoretical/empirical approach.

Empirical Tests of Models

The model described by Tannenbaum and colleagues has been subjected to empirical test by several researchers at the University of Central Florida (Bowers, et al., 1992; Kline, Urban, Bowers, & Morgan, 1992; Urban, et al., in press). These researchers sought to investigate the utility of the Team Effectiveness Model as a guide and depiction of variables related to team performance research. In particular, Urban and her colleagues investigated the relationship among team process, outcome, individual and

team characteristics while manipulating two types of work characteristics. The work characteristics of interest in these studies were workload and structure. That is, teams were exposed to one of two levels of workload, low or high, and one of two types of structure, hierarchical or non-hierarchical. The individual characteristic of interest within these studies was coordination attitudes assessed via the Team Coordination Attitude Scale (TCAS; Weaver, Bowers, & Morgan, 1992). Several team characteristics were assessed. These characteristics were teamness (Trainee Self-Report Questionnaire-Morgan et al., 1986), team cohesion (a modification of the Sport Cohesion Instrument-Yukelson, Weinberg, & Jackson, 1984), and familiarity. The process variable investigated within the studies of Urban et al., (1992) was team communication. Team communication was recorded, transcribed, and coded according to an eight category system which was applied to all complete and intelligible thought units expressed by team members. Output measures were team score, acknowledgment time, and engagement time. Individual performance was also measured as monitoring reaction time.

The task in this series of studies was a five-member team task which requires teams to simultaneously perform a team resource allocation task and individual monitoring tasks, consistent with the synthetic work paradigm (Alluisi,

1969; Morgan & Alluisi, 1972). For a complete description of the task see Urban et al., (1992). The results of this study found partial support for the Team Effectiveness Model. With respect to the individual characteristic of attitudes, no support was found for a direct link between attitudes and performance. However, the authors suggest in Urban et al., (1992) that the relationship between attitudes and communication might be more significant. In regard to the work characteristics, team structure and workload, non-hierarchical teams performed better than hierarchical teams and there were no main effects of workload for team score. The authors note that team performance measures in regard to workload indicate that low workload teams emphasized team performance quantity while high workload teams emphasized team performance quality.

Results regarding team characteristics indicated no significant differences in teamness, however, teams who performed well reported higher cohesion than poor performing teams. Familiarity was assessed in order to rule out the effects of this variable. However, teams who performed well were neither more nor less familiar than teams who did not perform well. The authors note that while these results provide only partial support for the Team Effectiveness Model, their effort sought simply to sample the cells set

forth by the model in a preliminary attempt to assess the model's effectiveness.

Urban, et al., (in press) examined team communication behaviors (process) in relation to structure and workload (work characteristics), and team performance (output). The results of their communication analyses indicated that less effective teams tended to engage in different types of communications than did more effective teams. That is, poorer teams tended to use more question and answer sequences in their verbal interactions, while better teams made more efficient use of their interactions. The authors argue that superior teams appeared to better anticipate the needs of their teammates. Although no difference in communication was found under varying levels of workload, main effects of structure were found for several communication categories. Hierarchical teams engaged in more asking and responding behavior than non-hierarchical teams. One of the most interesting findings in these data was the significant interaction between workload and performance level. Under low workload, superior teams asked the same number of questions as poorer teams, while superior teams asked significantly fewer questions than poorer performers under high workload conditions. The authors hypothesized that the differential pattern of communication findings across structures might indicate that hierarchical

structure does not facilitate effective information transmission. This investigation into the relationship of communication, performance, structure, and workload provides an excellent example of the type of empirical tests needed to refute or support existing models of team performance.

The second research effort to be discussed here as an *a priori* test of an existing model, is Gladstein's (1984) research conducted as an investigation of a model based on McGrath's (1964) model. The purpose of this research was to test the hypothesis that "groups that exhibit maintenance behaviors, good decision making skills, and communication with external groups with which they are interdependent will be more effective (Gladstein, 1984, p. 501). It was also of interest to determine the extent to which these relationships existed when organizational variables and group composition were taken into account.

The model components investigated within the confines of this study were group effectiveness, group process, group task, group structure, group composition, and organizational inputs. Measures of group effectiveness were performance and satisfaction, and process measures were gathered via scales which assessed maintenance and task behaviors. The group task measures of interest were uncertainty, complexity, and interdependence. Group structure was assessed in relation to group size, roles, norms, and

leadership. The group composition variables of interest were adequacy of skill, group heterogeneity, job, and organizational tenure. Finally, the organizational inputs assessed here were group rewards for performance and supervisory control. In order to test the constructs assessed as listed above, Gladstein (1984) performed a confirmatory factor analysis. The final set of factors determined by the confirmatory factor analysis were intragroup process and boundary management as group process; and size, leadership, and structuring of activities as group structure. Performance and subjective effectiveness were indicated as group effectiveness variables. Gladstein also tested the hypothesis that group task characteristics would moderate the relationship between process and effectiveness. This hypothesis was not supported. However, Gladstein noted that this might be due to a lack task variability within the confines of this study. That is, task complexity was reported to be uniformly high requiring a great deal of interaction between group members.

Gladstein tested the model using the LISREL path analytic technique. Results of this analysis indicated that intragroup processes, leadership, training, and organizational tenure accounted for much of the variance in self-reported effectiveness. Her test of the full model indicated that structure conceived as work norms, goals,

role clarity, leadership, and task control were directly related to boundary management and intragroup processes (process). However, size as a component of structure related only to intragroup processes and not boundary management. Organizational experience was related to self-reported effectiveness and sales revenue, while training related only to self-reported effectiveness. Finally, leadership and structuring of activities were influenced by rewards.

The finding labeled as most striking by Gladstein was that there is a need for more accurate theories detailing factors which impact performance and these theories should be communicated to employees. This statement was made in response to the finding that group members appear to be uninformed regarding the factors which determine their performance. That is, Gladstein's research indicated that group members attributed sales to their own experience and interactions. However, it was actually market growth, low experience levels and other variables as yet undetermined which predicted sales revenue.

The final example to be considered here as an illustration of research which empirically tests theory is the work of Komaki, Desselles, and Bowman (1989). These authors sought to investigate the extent to which an operant model of supervision might be considered for teams while

also considering the team as interdependent and the leader's role therein. The teams considered by Komaki and her colleagues were sailboating teams participating in a sailboat regatta for the purpose of conducting the research, and the leaders of interest were the skippers of the sailing crews. The measure of leader behavior was the Operant Supervisory Team Taxonomy and Index (OSTTI) previously developed by Komaki and her colleagues (Komaki, Zlotnick, & Jensen, 1986). Observers were trained as raters of the categories depicted within OSTTI.

Results indicated that two key components of the model, performance consequences and monitors, were associated with series standing in the hypothesized direction. However, coordination statements were not significantly related to series standing, discounting this hypothesis. The authors note that the findings regarding monitoring and consequences provides support for two key components of the model. However, implications regarding coordination as a model component are less compelling. The authors argue that while their results are promising, there is a need for more studies of this type. That is, a primary advantage of their study was that "it built on an existing model and a body of evidence in support of the model" (Komaki et al, 1989, p. 528). Komaki's research provides an excellent example of an investigation which makes a

contribution to team research by positing and empirically testing the utility of a model.

Conclusions

The purpose of this section has been to consider progress in answering the question "what are the unique features of teams" posed by Dyer over ten years ago. Consequently, it has been our contention that this question can be conceptualized as related to two issues. Thus, we have considered researchers' progress in arriving at an acceptable definition of teams and described researchers' efforts to detail a useful model of teams process and performance. We have also argued that the field of team performance research can best be propelled by a slight alteration of focus in the manner in which researchers pursue this line of research. That is, based upon the review of the team performance literature regarding team definitions and models, this manuscript has espoused two primary ideas. Although these ideas are not totally new or controversial, they are meant to serve as a reminder that an understanding of team process and performance might best be gained by considering (1) team interdependence as a key factor in relation to their process and outcome and (2) the importance of conducting empirical tests of models and theories meant to serve as explanatory mechanisms of team development, process, and performance.

It has been noted that a team's interdependence can differ at several levels. Interdependence at the task, goal, and feedback level all determine the manner in which a team performs. In addition, it is noted that inconsistency across these dimensions can hinder a team's performance. Perhaps investigations of team interdependence might yield useful information regarding the extent to which the interdependence of teams' in fact impact team interactions. The interdependence construct was described, in part, as a response to researchers who might continue to state that no good definition of "team" exists. It is our current contention that team definitions are currently adequate. However, it is also necessary to acknowledge that teams might fit the definition offered here to a greater or lesser extent in relation to the interdependence of the teams/groups of interest. By considering the interdependence construct as a continuum along which teams/groups can vary, communication among researchers might be facilitated.

The need for empirical research to test theories and models developed as explanations of team performance is also an important issue. By continuing to develop theories in the absence of empirical work devoted to their investigation, little knowledge will be gained about the accuracy with which these models depict the phenomena. The studies reviewed here were meant to serve as examples of

research which is being conducted for this purpose. While this review was obviously somewhat limited, there has relatively little of this type of research conducted. It would appear that greater advancement might be made within the field if efforts were devoted to merging the two interests.

Given the progress of the last ten years toward answering Dyer's question regarding the unique features of teams, it is possible to look toward the future in an attempt to describe where this area of research should be ten years from now. Because we can now say that we have a good idea of what teams are in general, we can now begin to target other characteristics which allow us to distinguish between *types* of teams (e.g., interdependence). This circumstance, coupled with a concerted effort to construct *and test* team descriptive models, will allow us to formulate general principles regarding teams and thus increase the utility of the accumulated knowledge. That is, by systematically considering the level of interdependence and types of teams for which certain relationships exist, accompanied by concerted efforts to test and refine team performance models, researchers can move toward optimizing the understanding of team performance. This understanding would ultimately allow researchers and practitioners to select and train team members, or design systems in such a

way as to maximize performance in all circumstances. This taxonomic approach will only be facilitated by improved focus on the test and revision of team performance models and the delineation of circumstances in which particular relationships hold true.

What are the characteristics of good teams?

Several characteristics have been postulated to contribute to effective team performance. In order to organize our presentation, we will present these factors using three cells from the previously described Team Effectiveness Model. Specifically, we will discuss variables related to individual characteristics, team characteristics, and team processes.

Individual Characteristics

Individual proficiency. It has been suggested that much of team performance can be predicted by the competencies of the individual members. Given this assumption, one might question the value of teamwork in team performance. Unfortunately, little research has been dedicated to determining the value of teamwork relative to individual task performance. In one of the few exceptions, Stout, Salas, & Carson (1994) assessed the degree to which critical sub-task competencies influenced team process and overall team performance. The results indicated that, although there was no relationship between individual skill

and team processes, teamwork behaviors predicted significant variance in team performance above and beyond that explained by individual task competence. However, it is unclear whether these results generalize to the wide range of team tasks encountered by military personnel. It seems likely that highly interdependent teams are most likely to benefit from efficient team processes. Yet, it is also possible that the role of teamwork is less direct. There is a need to explore this issue further in order to target training resources to arrive at optimal performance.

Personality. The role of member personality has received relatively little investigation. Recently, researchers have begun to explore this area, however. For example, Chidester and his colleagues found a relationship between personality and crew performance in a simulated flight (see Prince et al., 1992 for a review). These researchers assigned subjects to one of three personality types based on their achievement motivation and interpersonal skills. The results indicated that crews led by captains high in each quality were most effective. Similarly, crews with captains that were lacking these qualities demonstrated less effective performance and poorer coordination. Orasanu (1991) reanalyzed these data to identify specific communication behaviors demonstrated by the different personality types during emergency periods.

She found that captains high on both traits used conversation with high degrees of planning and strategizing. They also tended to gather information and make predictions more frequently. Conversely, captains low on each trait communicated less and engaged in less conversation regarding problem solving. These effects indicate the need for an accelerated program of research to investigate the effects of personality on team performance more fully.

Driskell, Hogan, & Salas (1987) have recently reviewed the literature regarding personality and group performance and have arrived at six summary hypotheses: 1) Intellectance will be positively related to successful performance in intellectual and imaginative tasks, 2) Adjustment will predict performance in all task types, 3) Prudence will be positively related to performance in mechanical and logical tasks, 4) Ambition will be related to performance in mechanical, intellectual, manipulative,a and logical tasks, 5) Sociability will be positively related to performance on imaginative and social tasks, and 6) Likability will be related to performance on social and manipulative tasks. These hypotheses continue to require empirical assessment, however.

Team Characteristics

Cohesiveness. Team cohesion has been discussed as an important motivational factor influencing team performance.

This construct has received a substantial amount of research attention in a variety of literatures such as business (see Wolfe & Box, 1988 for a review) and sports (c.f., McClure & Foster, 1991). However, less attention has been directed towards the cohesiveness of military teams. Although operational personnel rotation procedures such as the Cohesion Operational Readiness and Training (COHORT) approach have been designed to increase unit cohesiveness, these approaches are often based on very basic assumptions of the nature of team cohesion. There is a need, however, for a more scientific understanding of the nature of cohesion and the elements which engender it in teams. The following paragraphs will attempt to describe the state of the literature regarding this important variable.

A primary issue in researching team cohesion lies in the definition and measurement of the construct. Largely, cohesion has been considered as the degree to which members value membership in the group and desire to remain in the group (Eddy, 1985). Consequently, cohesion can be thought of as the aggregate of several component variables, such as mutual admiration, acceptance of the group's goals, and satisfaction with the group's leadership style (Wolfe & Box, 1988). While this definition appears to be accepted by the majority of scientists in this area, the measurement of team cohesion often does not reflect all of these component

elements. Consequently, as pointed out by Dyer (1984) the measurement of this variable, like many in team research, is based on rather informal assessment procedures. For example, research in cohesion is often based on unidimensional scales, despite the multidimensional nature of the construct. This lack of agreement between definition and measurement can be identified as a primary source of the mixed results typically found in the literature.

Some progress has been made in the measurement of team cohesion since Dyer's review, however. Most notably, Griffith (1988) describes a study designed to identify the components of team cohesion in a large sample of soldiers. Using items from several existing measures of cohesiveness, the author identified four dimensions that characterize cohesiveness in Army units. These were quality of instrumental and affective relationships among junior enlisted soldiers, the quality of the relationship between junior enlisted personnel and their leaders, soldier's internalization of the Army's values, and soldier's confidence in their weaponry and their leaders. Furthermore, the validity of these scales was supported by several tests. The scales were correlated with desire to remain in the unit, soldier morale, and satisfaction with the Army. Furthermore, the scales accounted for substantial variance in soldier's perceptions of their unit's readiness.

Consequently, it might be the case that by measuring unit cohesiveness through this multidimensional approach, we can begin to develop a much more thorough understanding of the effects of cohesion.

With respect to the effect of cohesiveness on group decision making, Wolfe and Box (1988) suggest that motivation must be taken into account. When motivation is high, higher cohesiveness is associated with effective decision making. Available findings concerning the relationship between cohesiveness and decision making are equivocal, however, in that Janis (1982) contends that cohesiveness could be detrimental to decision making if it leads to a narrowing of alternatives, or groupthink. With respect to the relationship between cohesiveness and coordination, the available data are also equivocal. Given these effects, the nature of the relationship between cohesiveness and coordination depends, to a certain extent, on the team's objective. For example, if team members are required to demonstrate high morale and stay banded together for an extended period of time, high cohesiveness, which is associated with high team member satisfaction (Manning & Fullerton, 1988), is likely to have positive effects on team coordination.

The research regarding cohesiveness and performance has been characterized by mixed results. Reviews of this

literature have been equally contradictory. While some of this confusion can be attributed to the conceptual and measurement issues described above, there appears to be an ample empirical base upon which to base preliminary conclusions. A recent meta-analytic study by Mullin and Cooper (1994) seems useful in synthesizing this literature. The authors considered the results of 49 published studies which tested to cohesiveness-performance effect. The results indicated a highly significant effect of cohesiveness on performance. However, the magnitude of the effect was small, and was impacted by a variety of external variables including experimental design, nature of the group (the magnitude of effect was stronger in real versus contrived groups), and group size. Thus, the mixed results demonstrated in individual studies might be due to failure to consider these critical moderating circumstances.

Inter-positional uncertainty. Baker and her colleagues have suggested that the lack of a clear understanding of appropriate operation behaviors for each team member, or inter-positional uncertainty (IPU), is related to team performance (Baker, Salas, Cannon-Bowers, & Spector, 1992). Results from an empirical study provide some support for this hypothesis. The authors manipulated IPU in a simulated flight task by altering training (i.e., in the low IPU condition subjects received training in both pilot and

copilot duties, in high IPU subjects received only training relevant to their position). The results indicated that high IPU teams demonstrated a lower quality of coordination and poorer team spirit. These data are interpreted as support for cross-training as a team training method.

Proximity. Member proximity, i.e., the physical distance between members of a team, has been empirically shown to influence interpersonal communication in a wide variety of settings (e.g., Emurian, Emurian, & Brady, 1978; Keller, 1986). Historically, research pertaining to the effects of proximity in small groups has concluded that communication decreases as distance between individuals increases (cf. ,Byrne & Buehler, 1955; Lundberg, Hertzler, & Dickson, 1949; Maisonneuve, 1952).

With respect to the effects of member proximity in organizations, Zahn (1991) has suggested that"...distance has not been an explicit variable in the information-processing and decision-making literature" (p. 739). Although research has rarely assessed the effects of member distance on team performance directly, the effects of distance on cohesiveness have been studied. Cohesiveness, in turn, has been demonstrated to influence decision making and coordination.

Other studies have focused on the relationship between proximity and communication behavior. For example, Keller

and Holland (1983) have demonstrated that smaller physical distances between employees in a research and development organization were associated with greater diffusion of task relevant information. Decreasing physical distance between individuals has been demonstrated to increase the likelihood of self-disclosure (Hazelwood & Schuldt, 1977), and sociability (Emurian, et al., 1978), but intrudes upon privacy feelings (Sundstrom, Town, Brown, Forman, & McGee, 1982; Zalesny & Farace, 1987).

In addition to physical distance, Katz and Kahn (1978) suggest that the effects of psychological distance (i.e., perceived distance) must also be considered. Two proposed sources of psychological distance in organizations are chain-of-command distance, and status distance. Chain-of-command distance refers to the number of intermediate steps in the organizational chart through which a message must pass between two employees. Status distance refers to the number of different levels of the organizational hierarchy that separate two employees. Zahn (1991) demonstrated that chain-of-command distance and status distance are related to physical distance. Increased psychological distance resulting from these variables tends to decrease communication to a greater extent than would be expected based on physical distance (i.e., distance between offices) alone. Zahn (1991), however, does not discuss the

relationship between psychological distance on decision making and coordination.

Communication Modality. Communication modality refers to the nature of the medium through which team members interact. The most prevalent modality for communication is face-to-face verbal interaction. In the available literature, a large number of studies have compared face-to-face, paper-mediated, audio-mediated, computer-mediated, and video-mediated communication.

With respect to the effects exerted by a computer medium on team processes, a preliminary discussion of the fundamental differences between interacting face-to-face and interacting through a computer is in order. According to Kiesler and her colleagues (Kiesler, Siegel, & McGuire, 1984; Kiesler & Sproull, 1992), interacting via computer severely limits the cues regarding social context that are available in face-to-face communication. That is, when group members can see each other, they can perceive cues pertaining to the status of each group member. Group members receive this information in various ways, for example, by observing who is seated at the head of the table or who is wearing a high ranking insignia. When using only a computer medium, however, this information might be absent.

Another potentially important difference between interacting face-to-face and through computer concerns the feedback provided when a group member sends a message. When interacting face-to-face, the sender of a message can receive feedback visually. By observing the facial expressions and nods of his/her group members, the sender can infer how well the message was understood, and adapt subsequent behavior accordingly (e.g., to expand on the point, to stop talking, etc.). When conversing through computer, this visual feedback cannot be provided. Therefore, the absence of status cues and visual feedback makes communicating through computer much different than standard face-to-face communication, as evidenced in the following set of empirical results.

Many of the sinvestigations of the effects of computer mediation concern its effects on decision making. For example, several studies have concluded that it takes significantly more time for groups to make a decision when they communicate by means of computer, compared to the time required by groups communicating face-to-face (Dubrovsky, Kiesler, & Sethna, 1991; Kiesler, et al., 1984; Siegel, Dubrovsky, Kiesler, & McGuire, 1986).

Although the relationship between computer mediation and team communication has not been tested directly, it has been shown that the relative participation of group members

interacting via computer is different than that of face-to-face groups (Kiesler, et al., 1984; McGuire, Kiesler, & Siegel, 1987). Specifically, these studies show that the participation displayed by members of computer-mediated groups was more balanced across individual group members than that of face-to-face groups. Two studies (Dubrovsky, et al., 1991; McGuire, et al., 1987) have demonstrated that this more equal participation served to obscure status differences. Greater participation equity and obscuring of status differences is likely to facilitate more effective coordination, at least in some situations. For example, in the context of aircrews, it has been suggested that status differences between pilots and copilots result in reduced coordination (Foushee & Manos, 1981; Orlady & Foushee, 1987). In some instances, pilots have demonstrated a tendency to overlook the contributions of copilots, and copilots have failed to contribute sufficiently to their interactions with pilots. Hence, obscuring status differences and greater participation equity is likely to insure that team members will recognize team member contributions and make their own contributions, and hence coordinate more effectively.

Computer mediation has also been demonstrated to influence the nature of the communication that is exhibited among group members. Straus and McGrath (1994) suggest that

the use of computer-based communication is likely to lead to discussion and analysis that is not as in-depth or complete as in face-to-face groups. Kiesler and her colleagues (Kiesler, et al., 1984) demonstrated that, while the communication of computer-mediated groups was as task oriented as that of face-to-face groups, frequencies of hostile, insulting, and profane statements suggested that computer-mediated groups were significantly less inhibited in their communication than face-to-face groups. In fact, the tendency to engage in such uninhibited behaviors is so commonly observed in field situations employing the computer medium that this tendency has been coined "flaming" (Dubrovsky, et al., 1991; Kiesler, et al., 1984). Wellens (1987) also demonstrated that computer mediation facilitates the exchange of socio-emotional communication. It has been suggested that the lack of feedback through the visual channel induces the sender to state his/her message more overtly than if stating it face-to-face (Kieser, et al., 1984). Without knowledge of how one's message is understood, the sender might also be more easily frustrated, and hence, uninhibited in his/her communication.

Team Process

Recent research has emphasized the importance of process variables in team performance. Studies such as that

conducted by Whitaker and her colleagues have demonstrated that military crew performance decreases as the intelligibility of communication degrades (Whitaker, Peters, & Garinther, 1990). The information transferred via these process behaviors is clearly crucial in the eventual success of the team. Consequently, understanding the nature of effective team processes has become a frequent subject of team research.

Bowers, Urban, and Morgan have attempted to extend the work of Kleinman and his colleagues by studying actual verbal communication in larger teams (Bowers et al., 1992, Urban, Bowers, & Morgan, 1993). Although these researchers failed to fully replicate the results of Kleinman and Serfaty (1989), they did suggest that the nature of effective communication might vary as a function of team structure. In non-hierarchical teams, communication frequency was positively correlated with performance. Hwoever, there was a negative correlation in hierarchically structured team.

The desire to improve safety in military aviation has also motivated research in team communication. In his analysis of Army helicopter accidents, Leedom (1990) concluded that faulty communication was one of four prominent causal factors. Thus, researchers have attempted

to understand the nature of effective communication in order to allow appropriate training development.

Oser and his colleagues analyzed transcripts of tactical rotary wing crews in a simulated mission (Oser, Prince, Morgan, Simpson, 1991). The results of this study indicated that there were significant differences in communication between pilots and copilots. Further, they found that communication frequencies changed as a function of mission requirements. Consistent with the results of Kleinman and Serfaty (1989), communication frequencies were reduced during periods of high mission requirements.

Bowers and his colleagues have recently advocated the use of pattern analysis techniques as another approach to investigating effective team processes (Bowers, Braun, & Kline, 1992). They demonstrated that the analysis of two-category sequences was more effective in predicting performance on a simulated aerial reconnaissance task than were simple frequency analyses. It is likely that additional pattern-based analyses will emerge in future literature.

Research has also been directed towards other team process behaviors. Based on a review of the literature and needs analysis data, Franz and his colleagues have identified seven classes of coordination behaviors that exist in military aviation: Communication, Decision Making,

Situational Awareness, Leadership, Adaptability, Mission Analysis, and Assertiveness (Franz, Prince, Cannon-Bowers, & Salas, 1990). Studies have indicated that the use of these behaviors is associated with effective mission performance. For example, Stout, Cannon-Bowers, Salas, & Morgan (1990) reported that the quality of these coordination skills was significantly related to crew performance. However, Thornton and her colleagues noted that the frequency of these behaviors might not be linearly related to performance. In fact, poor crews seemed at risk to perform these behaviors more, presumably in an attempt to recover from past mistakes (Thornton, Braun, Bowers, & Morgan, 1992).

What variables influence team behavior?

The TEM includes three classes of variables that are external to the team which might influence the team's behavior: Organizational and situational characteristics, task characteristics, and work structure. The following will review the research progress relevant to variables within each of these broad classes.

Organizational and Situational Characteristics

Environmental uncertainty. Environmental uncertainty is frequently included as a key element in understanding the performance of teams in the naturalistic environment (e.g., Orasanu & Salas, 1993). In large part, it is assumed that

uncertainty about the environment in which performance must take place is likely to have a critical impact on team performance, and it is not difficult to find anecdotal evidence from a variety of team tasks to support this notion. There is very little empirical evidence, however, to assess the impact of environmental uncertainty.

The largest concentration of literature regarding this construct is found in the organizational psychology literature, where the role of environmental uncertainty on business decision making has received research attention. Generally speaking, the results of this research indicate that environmental uncertainty is associated with more conservative decision making and management strategies (Bourgeois, McCallister, & Mitchell, 1978) and may intensify the effects of other types of uncertainty (Leblebici & Salacik, 1981). However, neither of these studies investigated team performance. There has been, as yet, no direct empirical test of the role of environmental uncertainty in teams. Because this effect is central to the operations of many military needs, there is a distinct need for research regarding team performance in the presence of environmental uncertainty.

Stress. Teams are often called upon to perform under conditions that are threatening to the members. For example, several military applications require operators to

perform their tasks while concurrently under threat of enemy fire. Consequently, reserach has recently investigated the manner in which stress degrades team performance and the effects of interventions that might help to maintain performance under these conditions.

Several studies have considered variables such as workload, time pressure, coordination demands, etc. under the umbrella of stress research. However, this discussion will focus on environmental variables, that emerge from outside the team or the tasks performed by the team. Other stress factors will be considered in subsequent sections as either team or task characteristics.

Perhaps the most direct test of the effects of environmental stressors on terms is that reported by Driskell and Salas (1991), who focused on group decision making performance under threatening conditions. They required groups of sailors were asked to make a decision about which of two ambiguous checkerboard slides contained more white area. Stress was manipulated by telling subjects that they would be performing the task in a simulated tear-gas drill. They also instructed subjects that only their final score would count towards the team score, which served to increase their individual stake in the task. Because the authors were interested in the degree to which member status effects decision making, they also manipulated the status of

subject's partners by using a confederate of either high or low military rank. The results of the Driskell and Salas study indicated that low status group members were likely to defer to their higher status partners. Furthermore, this trend was especially salient during periods of stress. Additionally, Driskell and Salas report that, under stress, higher status members were more receptive to input from subordinates.

While the Driskell and Salas study represents a rare attempt to experimentally investigate the effects of environmental stress on team performance, their are several factors that serve to limits its generalizability. For example, the task is a contrived laboratory task that may possess relatively little external validity. Also, the nature of the task is such that there is relatively little interdependence, which might limit the generalizability to other types of teams. That notwithstanding, until ongoing studies of threat and team performance are completed (i.e. Weaver, in preparation), this study represents the state-of-the-art in research on threat and teams.

In reviewing the literature regarding stressors and human performance, it is not unreasonable to surmise that several other environmental stressors are likely to influence team performance. For example, noise is likely to disrupt team process and, therefore, reduce performance.

Similarly, extreme temperatures, vibration, and other common workplace stressors are all likely to disrupt communication and coordination among team members. However, because these effects have not been empirically tested and documented, the actual effects of these stressors is not yet known. Clearly, this is an area requiring a great deal of additional research attention.

Task Characteristics

Workload. Teams are often employed because the workload associated with specific tasks is greater than can be tolerated by individual operators. It is not surprising, then, that the issue of workload and teams has received considerable interest from researchers in this area. The conceptual and empirical literature in this area is reviewed below.

One area of research has been to validate the advantage of teams over individuals in high workload situations. For example, Bieth (1987) conducted a study to assess the degree to which membership in a team resulted in the workload savings that have been hypothesized. He compared the performance of individuals and teams during a problem solving task. In general, the results indicate that perceived workload was lowest in teams with unlimited communication opportunities. The advantage of performing in

a team was largely eliminated when communication within the team was restricted.

The more common consideration of workload has been to diagnose its effects on team performance. One particular area of interest has related to the degree to which workload effects the ability of teams to arrive at effective decisions. For example, Kleinamn and Serfaty (1989) describe a study which required teams of three subjects to perform a computerized dynamic resource allocation task. The task was designed such that teams were required to make decisions regarding the appropriate allocation of a pool of common resources in order to engage a series of simulated targets. Team workload was manipulated by altering the target arrival rate. The dependent variables in this study included not only team performance, but also frequency of computer-mediated communication behaviors (such as requests for resource transfers). The results of this study indicated that as workload increased from low to medium, subjects increased the frequency of task-related communication or "explicit coordination." However, as workload increased from medium to high, the rate of communication decreased drastically, such that the majority of resource transfers were unsolicited. Performance, however, was maintained. This pattern is described by Kleinman and Serfaty (1992) as "implicit coordination."

Researchers at the University of Central Florida have conducted studies to further assess the role of workload on team performance (Bowers, et al., 1989; Urban, Bowers, Morgan, Braun, & Kline, 1992; Urban et al., in press). These studies investigated whether patterns similar to those described by Kleinman and Serfaty emerge in larger teams that were afforded natural, as opposed to computer mediated, communication. In these studies, workload was manipulated by altering the decision complexity rather than the decision speed, another important difference from Kleinman and Serfaty (1989). The results of the Central Florida studies have yielded somewhat complex results. For example, Urban and her colleagues (1992) report that although there was no performance difference between high and low workload groups, the teams performing under high workload communicated more frequently than those performing under low workload. Additionally, low workload teams demonstrated more task-related statements while high workload teams demonstrated a greater frequency of non-task related comments. These findings are not completely consistent with those of Kleinman and Serfaty (1989). In fact, one would have expected that teams under high workload would be more likely to demonstrate decreased communication. Several hypotheses can be identified which might explain this difference: 1) communication differences are dependent upon communication

modality, 2) the differences might be due to the different team size, 3) the conflicting results might have been brought about by the difference in the workload manipulation, or 4) the data from verbal communication is not comparable to computer mediated communication because of the variety of content areas in the former. Subsequent studies have attempted to explore the effects of workload on team performance and communication more fully. Urban and her colleagues (in press) compared the effects of workload (again manipulated by decision complexity) on two different team structures: non-hierarchical and product structures. Again, there was no performance difference associated with the workload manipulation. However, a more detailed analysis of communication behaviors demonstrated no significant differences in communication behaviors between the two workload groups. The frequency of responding was analyzed as a test of the notion of implicit coordination. The results indicated that, under low workload, there was no difference in the frequency of responses between low and high performing groups. However, under high workload, better performing teams demonstrated fewer responses than did their poorer performing counterparts. This finding is consistent with the idea of implicit coordination. However, it also serves to demonstrate that overall communication frequencies are probably not as sensitive to workload

effects in natural communication as in relatively constrained computer mediated communication.

Taken as a whole, the results regarding workload and team performance are far from conclusive. Certainly, one reason underlying these contradictory results can be attributed to the manner in which workload is defined, measured and manipulated in teams (see Bowers, et al., in press for a more thorough discussion of these problems). Typically, manipulations of workload are alterations designed to make the task more difficult. While these alterations are often "face valid," their construct validity can be questioned. For example, none of the manipulations described above created a significantly higher subjective workload rating in the supposedly high workload groups. Consequently, it is not clear whether the manipulations are insufficient to create workload, or whether subjective measurement techniques are insensitive to team workload changes.

The manner in which teams cope with workload is a critical concern for many applied areas. Although the research described above is a substantial improvement over the state-of-the-art described in the Dyer (1984) review, it is clearly insufficient for understanding and improving work team performance under varying workloads. Consequently, it

is anticipated that this will be an increasingly popular area of research.

Time pressure. Teams are often called upon to operate under conditions of considerable time pressure. Necessarily, therefore, there is a need to understand the effects of time pressure on team performance and to identify training strategies that allow teams to maintain their performance in high time pressure conditions. There have been few empirical studies of this topic. However, Lehner and his colleagues investigated the degree to which time pressure would bring about cognitive biases in decision making teams (Lehner, Syed-Solorforough, Nallappa, O"Conner, Sak, & Mullin, 1992). Using a PC-based decision making task, they indicated that decision making grew increasingly unreliable with increased time pressure. Similar effects have been described by Ilgen, Hollenbeck, Sego, Major, Philip, and Hedlund (1992). There is a need, however, to establish the degree to which these finding generalize to other military tasks.

Automation. One of the most salient changes in the workplace since the publication of the Dyer review has been the introduction of automation into the workplace. Automation is believed to assist team members by "taking over" some aspects of the task to free resources for use in the execution of other tasks. However, the early research

in this area suggests that automated systems might have some unintended effects of team performance. For example, Laudeman and Palmer (1992) investigated the workload of operators performing in traditional cockpits and automated cockpits. Crews which performed in traditional cockpits perceived lower workload levels. The researchers also compared the workload levels of crews in automated cockpits who either chose or declined to use the automated features. Crews that used the features perceived higher levels of workload than crews that did not use these systems. These findings are in clear conflict with a primary goal of automated systems (i.e., to reduce operator workload).

Additional research has demonstrated that automation does not necessarily produce enhanced performance. For example, Thornton and her colleagues have reported that crews in automated conditions did not demonstrate any performance advantage on an aviation decision making task (Thornton, et al., 1992). In other words, crews were not able to employ workload savings afforded by automation to enhance their performance on another aspect of the task.

Automation is also likely to effect the nature of crew processes. For example, Segal (1994) notes that new technology changes the nature of important non-verbal cues demonstrated in complex systems. An important non-verbal source of information is provided when operators interact

with displays and controls in a manner that is apparent to other operators. Automated systems, such as multi-functional displays, have the potential of modifying the nature of information provided by this type of non-verbal information. Segal (1989) notes that the information available to other team members may be altered as automation reduces the control actions of operators.

Additionally, Bowers and his colleagues have recently described a laboratory study in which the effects of automation on communication were assessed during a simulated flight (Bowers, Deaton, Oser, Prince, & Kolb, in press). Specifically, they were interested in the degree to which automated systems might make resources available that would contribute to more effective decision making. Once again, automation was not related to more effective performance. However, there were some interesting communication differences. In manual aircraft, there was little distinction between the communication of effective and ineffective performers. However, poor performers in the automated condition displayed significantly higher frequencies of unsolicited observations and responses to these observations. Several other communication differences converged to suggest that the nature of effective team processes might be quite different in automatic systems.

Clearly, automation is likely to be one of the key variables in future research on team performance. Toward this end, Bowers and his colleagues have recently provided a series of research directions for this important variable (Bowers, Oser, Cannon-Bowers, & Salas, in press). These include factors such as the interaction of automation and individual characteristics, the need for adaptive automation of team processes, and the selection of sub-tasks for automation.

Feedback. Feedback is likely to be an important factor influencing skill acquisition and maintenance in teams (Nadler, 1979). Feedback is thought to exert its influence via several mechanisms: reinforcement of learning (Alexander & Cooperbrand, 1965), provision of cues for goal-setting (Johnson, Perlow, & Piper, 1993), and reduction of social loafing (Hardy & Latane, 1986).

The provision of feedback appears to be generally accepted as a method of improving team training (CF. Gaddy, 1987; McIntyre, Morgan, Salas, & Glickman, 1988; Swezey & Salas, 1992). However, this guidance seems to be based more on common sense than on empirical literature. Clear and difinitive guidance is still lacking concerning how and when to provide feedback regarding the various elements of team performance. A few studies relevant to this problem have been published and are reviewed below.

The question of whether to direct feedback to individuals or to teams has been explored by Matsui, et al.,). After comparing performance conditions, they concluded that a combination of individual and team feedback should lead to optimum performance. They argue that members can benefit from individual feedback even if the team is already achieving its goal. Furthermore, they suggest that adequately performing individuals can utilize team feedback to alter their behavior to trade off between individual and group demands more efficiently.

Jentsch and his colleagues have explored the degree to which feedback influences the decision to allocate resources to either individual or group demands (Jentsch, Navarro, & Bowers, 1994; Jentsch, Navarro, Braun, & Bowers, 1994). The impact of team, individual, and no feedback were directly compared using a reciprocally interdependent team tracking task. Neither study revealed a salient effect of feedback on overall team performance. However, the study did indicate that feedback was useful in directing attention to various aspects of the overall task.

In summary, although feedback is generally considered to be an essential element of team training, the scientific literature regarding this factor is lacking with regards to the design, target, and timing of appropriate feedback for teams. Blickensderfer, Cannon-Bowers, and Salas (1994) have

recently described a number of hypotheses which require testing before the role of feedback in team behavior is fully understood. Consequently, there is a need for increased research to explore this important training issue.

Work Characteristics

Structure. Work assignment, or structure, has been hypothesized to effect team process and performance, and empirical research appears to support this contention. Kleinman and Serfaty (1989) manipulated structure by varying the overlap among team members in a simulated resource allocation task. The authors concluded that complete overlap was associated with better performance under low and moderate levels of workload. Under high workload, however, partial overlap was associated with more effective performance.

Bowers and his colleagues have compared hierarchical to non-hierarchical structures in a similar resource allocation task (Bowers et al., 1992). The results indicate that, regardless of workload level, hierarchically arranged groups suffered a disadvantage in performance. Because the military is composed largely of highly structured teams, there is a need to diagnose the nature of this performance disruption and to identify training interventions to reduce it.

Attitudes. The role of individual attitudes in team performance has received considerable research attention lately, due largely to the effort of Helmreich and his colleagues at the University of Texas. In their research on improving flight performance, they have targeted attitudes toward coordination as a key element in eventual crew performance. Helmreich (1984) argues that although personality and attitudes are related, and that both might influence crew behavior, attitudes are less permanent and might be amenable to training.

This hypothesis has been the impetus for a large program of research. One element of this program has been to develop and validate a Cockpit Management Attitudes Questionnaire (CMAQ; Helmreich, 1984; Helmreich, Wilhelm, & Gregorich, 1988 to measure of attitudes towards coordination. The scale includes 25 items related to cockpit resource management (i.e. "The pre-flight crew briefing is important for safety and for effective crew management"). Subjects indicate their agreement using a 5-point Likert scale. The scale appears to possess adequate psychometric qualities (Helmreich, 1988). Furthermore, factor analysis indicates the presence of three factors: Communication and coordination, command responsibility, and recognition of stressor effects (Gregorich, Helmreich, & Wilhelm, 1990). These factors might be useful in assisting researchers

attempting to explore the attitude-performance link with more precision. Other researchers have concentrated on adapting the CMAQ to other populations, such as military pilots (Simon, Pawlik, & Bronkhorst, 1991) or general team settings (Weaver et al., 1992).

Having developed a technology for the measurement of attitudes, the challenge for researchers is to establish that these attitudes are, in fact, related to team performance and that they are amenable to training interventions. Researchers have made some progress towards this goal. For example, Helmreich and his colleagues compared attitudes for groups of pilots evaluated as above or below average by independent check airmen (Helmreich, Foushee, Benson, & Russini, 1986). The results of this study indicated that attitudes toward communication was a significant predictor of group membership. In fact, over 95% of the pilots in the sample were correctly classified based on their attitudes alone. Similarly positive results were obtained by Weaver and her colleagues using a laboratory team task (Weaver et al., 1992).

Data from preliminary cockpit resource management (CRM) training programs also supports the hypothesized attitude-performance relationship. For example, Helmreich (1990) reports that attitudes grew more positive following a CRM intervention. Furthermore, Simon and his colleagues (Simon

et al., 1991) report that attitudes contributed to the explainable variance in crew performance, even after considering actual behaviors displayed by the aviators.

Despite the strength of the research regarding attitudes and team performance, several important challenges remain. First, there is a need to demonstrate the relationship between attitudes and actual coordination behaviors. Preliminary studies have demonstrated surprisingly low correlations between attitudes and communication frequency (Bowers et al., 1991). While one might argue that communication frequency is not necessarily synonymous with communication quality (i.e., Bowers, et al., 1992), there is a need to associate positive attitudes with more positive communication behaviors. Additionally, there is a need to determine whether changes in attitudes, if they can be brought about, are related to changes in communication behavior. Despite these questions, however, the importance of attitudes in team performance seems well established, and this area of research is expected to remain active in the future.

How do teams develop?

The increasingly important role of teams in the workplace has imposed a sudden demand for training programs designed to optimize team performance. However, rganizational psychologists have been slow to respond to

this demand and the literature still provides relatively little guidance about how best to facilitate team performance (Swezey & Salas, 1992). Nevertheless, the past few years have witnessed a substantial increase in research designed to provide a basic understanding of the factors that influence teamwork, with the goal of providing direction for team training development (see Salas, Dickinson, Converse, & Tannenbaum, 1992 for a review). One conspicuous exception to the above trend relates to the development of newly formed teams. The importance of understanding team development is well documented. For example, Dyer (1984) remarks that "A training program needs to be based on a concept of what characterizes a good team and what stages, if any, a team goes through in its development" (p. 313).

Morgan and his colleagues have described a model to account for the development of military teams over time (Morgan, et al., 1986). The resulting Team Evolution and Maturation (TEAM) model proposes two tracks which must be concurrently executed in the development of newly formed teams. One track includes the specific taskwork behaviors required by the individual to perform his or her specific individual duties. Additionally, there is a teamwork track which includes activities necessary for the coordination of behaviors as well as the attitudes required for effective

team performance. As these tracks are mastered, effective team performance is hypothesized to result. Morgan and his colleagues have tested this theory by observing the development of newly formed Navy teams undergoing a four to five day period of training (Morgan et al., 1986; Morgan, Salas, & Glickman, 1994). Their data supported the contention that differential aspects of the task became prominent throughout the course of training. Early sessions were marked by greater weightings of raw task skills. Team skills grew more important in subsequent sessions. The final phase of training was associated with high loading on both teamwork and taskwork skills. Subsequent behavioral analysis was consistent with these findings (Oser, McCallum, Salas, & Morgan, 1989).

Gersick (1988, 1989) has suggested that teams develop via a sudden transformation that occurs at approximately half way into the team's life cycle, then remains fairly constant (i.e., "punctuated equilibrium"). While these conceptual approaches are interesting, there is little compelling empirical evidence with which to assess them. Furthermore, the few existing studies rely almost exclusively on naturalistic observation and are, therefore, subject to lack of experimental control of key factors. Finally, there has rarely been a direct measurement of the specific process behaviors that are believed to change.

Recently, investigators have attempted to isolate the specific behaviors associated with team development. For example, Salas and his colleagues analyzed the changes in novice pilots who flew together over a number of experimental trials (Salas, Bowers, Braun, & Jentsch, 1994). They concluded that the changes in team process were relatively subtle. They reported relatively little support for the idea of developmental stages. Rather, they suggested that the data were more consistent with Gersick's notion of punctuated equilibrium. Similar results were recently reported in a team decision making study described by Urban, Bowers, Morgan, and Maniam (1994).

Conclusion

Overall, it seems that the area of team development is one that has received the least research attention since Dyer's (1984) review. This might be attributed to the expense and difficulty associated with this type of research. However, this area of study is critical to the development of effective team training programs. Consequently, greater support of this research area is strongly recommended.

How should teams be trained?

Because the consequences of ineffective team performance can be devastating (as illustrated by such incidents as that at Three Mile Island, that involving the

USS Vincennes, and the crash of Pan Am flight 401), training teams to perform effectively is of critical importance. Although an immense literature exists concerning the training of individuals, much of this literature is not directly applicable to the problem of training teams. In her review, Dyer (1984) attempted to make specific recommendations concerning ways to improve the training and performance of military teams.

The current section attempts to review the progress that has been made in the area of team training since the time of Dyer's (1984) review. More specifically, the current discussion attempts to answer the questions that Dyer (1984) raised concerning the training of teams. These questions are: 1) what are team skills, and what team skills should be trained? and 2) how can training programs be designed and evaluated to effectively train these skills?

As previously described, Dyer's (1984) review primarily focused on military team training. The literature available at that time focused on the need to understand military teams or apply findings in the context of military teams. Since the time of Dyer's (1984) review, however, advanced technology has increased the complexity of a wide variety of work environments and teams have replaced individuals as the basic working unit in numerous settings. Thus, the need to further understand how to improve team performance through

training is also prevalent in many different contexts. The progress that has been made in the arena of team training demonstrates that researchers are now concerned with many different types of teams, e.g., nuclear control room teams, commercial aviation crews, teams in corporations, etc. Therefore, the current discussion includes contributions made in different domains, e.g., management, commercial aviation, etc., as well as in the military domain, to the state of the art knowledge concerning team training.

As noted earlier in this document, a "team" has been defined to include a set of two or more individuals, interdependent and adaptive interactions, and shared and valued objectives (Morgan et al., 1986). Furtehrmore, Morgan and his colleagues (Morgan et al., 1986) contend that as teams perform, team members engage in two different types of behaviors: namely, taskwork behavior and teamwork behavior. Taskwork activities involve the technical or operational aspects of the task at hand. Teamwork behaviors consist of those interactions that must occur between/among team members as they "interdependently interact", or coordinate, to collectively accomplish their given objective. A similar distinction is made by Davis and his colleagues (Davis, Gaddy, & Turney, 1985), who call these two types of activities operational and generic team skills, respectively. Thus, in answer to Dyer's (1984) question,

"team skills" become all of those behaviors which team members use in order to interact with other team emebers and to coordinate their related activities.

Aas noted by Morgan and his colleagues (Morgan, et al., 1986) training in many systems has focused on teaching people to work effectively with machines, but provides little guidance concerning how to interact with each other. Systems theory (e.g., Cherns, 1976) suggests that both types of interactions should be emphasized for effective performance. The issue of team skills training was addressed in a workshop sponsored by the Nuclear Regulatory Commission in the aftermath of the accidents that occurred at Three Mile Island and Chernobyl. Team experts from a variety of communities (e.g., military, aviation, academic, etc.) were invited, and according to Davis and his colleagues (Davis, Gaddy, Turney, & Koontz, 1986), one of the first areas of concern was ti define team skills and to distinguish them from the individual skills held by members of teams.

Although the team skill construct is intuitively appealing, the notion becomes much more complex when the question is asked: how can team skills be recognized or identified? Clearly, blind extension of methodologies developed to identify individual skills will not be appropriate for team skill identification. New methodologies that are sensitive to the sometimes subtle

interactions that occur between team members must be developed. Once team skills are identified, decisions must be made concerning which team skills are trainable and which should be trained in order to optimize team performance. That is, not all team skills are equally critical for effective team performance, nor or all team skills so complex as to require formal training. Once the elements to be trained have been selected, training must be designed. This includes determining the focus of the intervention, as well as deciding how to sequence training. For example, must team members necessarily be trained collectively for "team training" to occur? The appropriate sequencing of team versus individual skills training must also be determined. Next, the effectiveness of the training intervention must be evaluated. Depending upon the effectiveness of training, the decline of its effects over time must be delineated in order to determine when refresher training is needed. The bottom line of the current discussion is that team training is different from individual training. It is more complex, and therefore, depends upon the development of new techniques and methodologies.

The current state of knowledge related to team training can be further subdivided into the following areas: 1) the identification of critical team skills, 2) the selection of

team skills that require training, 3) the acquisition of team skills (i.e., program design and sequencing), 4) team training evaluation, and 5) remediation training for team skills. Although the phrase "team skill" has been employed here, the more accurate content of team training programs involves the knowledge and abilities to be obtained by team members, as well as necessary skills. Therefore, the remainder of the current review refers to the content of team training programs as team knowledge, skills, and abilities (KSAs).

Identification of Team KSAs

According to Goldstein (1986), the first stage in the development of an effective training program is a needs analysis. Although the three components of a needs analysis described by Goldstein (1986) only include person analysis, job analysis, and organization analysis, the job analysis is also particularly relevant for the identification of team KSAs. The current review of the literature finds a general lack of empirically supported techniques for identifying team KSAs and this is an area where additional work is needed. However, several approaches have been developed that represent significant improvements as compared to the state of the art reflected in Dyer's (1984) review. The following review is an attempt to describe significant contributions that have been made to further the development

of useful techniques and methodologies for identifying team KSAs.

Given the complexity of team performance, Levine and his colleagues (Levine, Brannick, Coovert, & Llobet, 1988) recommend that team task analyses must proceed, at least in part, in a top-down fashion (i.e., from more general to more specific levels). A commonly employed top-down approach involves the development of team task taxonomies. These task taxonomies represent general dimensions or classes of team KSAs that can generalize across a variety of tasks. For example, Shiflett and his colleagues (Shiflett, Eisner, Price, & Schemmer, 1982) revised a taxonomy originally developed by Nieva, Fleishman, and Rieck (1978). This taxonomy contains five categories of team functions: orientation (i.e., information exchange and priority assignment), resource distribution, timing (i.e., pacing), response coordination (i.e., sequencing responses), and motivational functions.

More recently, Fleishman and Zaccaro (1992) also propose a taxonomy of team functions that builds upon the work of Nieva and her colleagues (Nieva, et al., 1978). These researchers propose four dimensions of team task functions: orientation, organization, adaptation, and motivation. The organization dimension combines the resource distribution and timing dimensions from the

taxonomy of Shiflett and his colleagues (Shiflett, et al., 1982). Adaptation refers to the evaluation, monitoring, and adjusting of performance exhibited by individual team members as they perform the task at hand. Motivational functions refer to the development of norms, reward systems, cohesiveness, and conflict resolution. This taxonomy, and team taxonomies in general, are useful in that the dimensions represent the different ways that team members must interact with each other. These categories represent a framework within which more specific team KSAs can be further delineated. Research is needed, however, to provide empirical support for the utility of such taxonomies for teams performing in operational settings.

Another top-down technique established to analyze team tasks is called the Multiphase Analysis of Performance (MAP), developed by Levine and his colleagues (Levine & Baker, 1990; Levine, et al., 1988). The premise of the MAP system is that certain dichotomous variables exist that influence the choice of task analysis methodologies to be employed in particular team situations. One such variable of concern is the level of analysis; that is, is training primarily focused on the individual level or the team level? For example, when members of a given team or several teams are trained collectively, this can be considered "team level" training, as discussed using the MAP system.

However, if one particular team member is being trained, or if individuals who are each members of different teams (e.g., a group of copilots) are trained concurrently, then this is considered "individual level" training, according to the MAP system.

The second variable of interest in the MAP system is training content, which is categorized in this system as either production/technical or social/interpersonal. This distinction is comparable to the taskwork/teamwork distinction, respectively, proposed by Morgan and his colleagues (Morgan, et al., 1986). The third dichotomous variable of the MAP system concerns the extent to which the team has developed. Teams are considered to be either immature (i.e., expected to be experiencing salient developmental changes) or mature (i.e., extant). These three dichotomous variables can be combined into the following eight different training types: individual training, interpersonal content, mature team; individual training, interpersonal content, immature team; individual training, production content, mature team; individual training, production content, immature team; team training, interpersonal content, mature team; team training, interpersonal content, immature team; team training, production content, mature team; team training, production content, immature team.

For each particular category within which a given training situation could fall, specific recommendations are given concerning the job analysis methodologies that should be employed. For example, Levine and his colleagues (Levine, et al., 1988) suggest that flight crew coordination training for existing aircrews could be classified as team focused, interpersonal content, mature team. For this dimension, the job analysis should include critical incidents and subject matter experts to collect data on the interpersonal interactions that must be trained. Training Combat Information Center (CIC) teams, however, could be considered to have a more taskwork-focused content, according to Levine and his colleagues (Levine, et al., 1988). Therefore, training could be classified as team focused, production content, mature. The job analysis techniques most appropriate for teams in this category should make use of individual or group interviews and flow charts of the tasks performed by each team member.

Levine and Baker (1990) tested the effectiveness of the MAP system by analyzing the two-person performance of the flight simulation task presented by the Falcon F-16 Flight Simulator. This task required two team members to act interdependently to fly and shoot down enemy aircraft. According to the MAP system, the Falcon teams were classified as production focused immature teams that could

be trained either individually or as a team. A job analysis was conducted, following the MAP recommendations for both individual training and team training of production focused, immature teams. Subject matter experts rated the utility of the MAP system as employed in the task analysis of the Falcon crews and indicated that it was comprehensive, generated useful data for training design, and was user-friendly (Levine & Baker, 1990).

Another technique that has been employed to identify team skills is cognitive task analysis. Cognitive task analysis, according to Redding and Seamster (1994) has grown out of cognitive psychology, in terms of the state of knowledge concerning issues such as attention, decision making, problem solving, memory, and skill acquisition. Cognitive task analysis uses techniques from this domain, such as modeling and interviewing experts, to identify "1) the key job components; 2) the knowledge and skills required for similar job components; 3) important knowledge and skill differences between novices (perhaps intermediates), and experts, or between good and poor performers; and 4) the conditions which best facilitate learning." (Redding & Seamster, 1994, p. 192).

One topic of cognitive task analysis that has received particular attention in the context of team skills involves the extent to which team members hold similar or shared

mental models. It has been hypothesized that an increased sharing of mental models among team members increases the extent to which these individuals hold common expectations and understandings for their interactions and for task performance (Cannon-Bowers & Salas, 1990; Rouse, Cannon-Bowers, & Salas, 1992). Although interventions that assist in the development of shared mental models could be useful for training, research to date is equivocal and suffers because of the difficulties involved in measuring shared mental models.

While the previously described techniques depict a top-down approach to identifying team skills, several other methodologies have been developed that ascribe more to a bottom-up approach. For example, Dieterly (1988) suggests that the team task analysis should begin with analyses of each individual's job. Each behavior entailed in each team member's job should be described and depicted on a flowchart. By representing all behaviors as such, dependencies that exist between/among the jobs of two or more team members can be identified. Those jobs that require dependence between/among team members represent the team task content (Dieterly, 1988).

Another bottom-up approach was employed by Morgan and his colleagues (Morgan, et al., 1986; Glickman et al. 1987). These researchers employed a critical incidents methodology

to identify team KSAs that characterize effective versus ineffective performance. These researchers observed over ninety behaviors exhibited by members of Naval Gunfire Support teams. The occurrence of particular behaviors allowed effective teams to be distinguished from ineffective teams. These critical team behaviors were then classified into the following dimensions: communication, coordination, team spirit and morale, giving suggestions and criticism, acceptance of suggestions and criticism, cooperation, and adaptability. These dimensions were then used by instructors during training to guide their assessment of the team training progress.

Franz and his colleagues (Franz, et al., 1990) employed a bottom-up methodology to identify the team skills that were demonstrated to be important by members of a military helicopter community. Based on a review of the aircrew coordination literature and interviews with helicopter pilots, fifty-five behavioral statements related to effective interaction (i.e., coordination) were compiled. These behaviors were rated by job experts (i.e., pilots) who indicated these to be important aspects of flight, as indicated by ratings of frequency, criticality, and importance to train. These skills were then classified into the following seven dimensions: communication, situational awareness, decision making, mission analysis, leadership,

adaptation, and assertiveness (Franz, et al., 1990). These seven dimensions represent the components of coordination, and are used not only as categories of a particular training evaluation tool (i.e., the Aircrew Coordination Observation/Evaluation form, or ACO/E), but also guide training interventions employed in the Navy's Aircrew Coordination Training (ACT) program (Prince, Chidester, Bowers, & Cannon-Bowers, 1992).

In summary, some work has been performed to establish methodologies to identify team KSAs. Of the approaches that have been reviewed, one in particular seems to show a great deal of promise in terms of its potential utility. That is, the MAP system seems particularly useful because it incorporates a variety of task analysis methodologies. Furthermore, its three dimension classification scheme (i.e., level of analysis, training content, and developmental level), provides recommendations that are specifically tailored to a given training situation, hence allowing for application to a number of different types of teams. While the utility of the MAP system has been empirically supported in one study (Levine & Baker, 1990), further research is necessary to test this system on a number of different types of teams, in order to provide evidence that supports this system's versatility.

The previous discussion of team skill identification has focused primarily on ways to identify team skills. However, some discussion is warranted concerning what team skills have been commonly identified in research conducted to date. As previously defined, team skills refer to the interactions that occur between or among members of a team. As discussed in a review conducted by Swezey and Salas (1992), the following team skills have been commonly identified, based on a consensus of research conducted since Dyer's (1984) review: sequencing communicated information properly to insure team members have needed information, using proper terminology when communicating, asking for clarification when needed, double checking team members and providing peer critique, providing team mates with feedback in appropriate, non-threatening ways, and appropriately accepting constructive feedback.

Selection of Team KSAs

Once the relevant team knowledge, skills, and abilities have been identified for a particular situation, it is important to focus training efforts on the subset of KSAs for which training is necessary or likely to be effective. In order to provide definitive recommendations concerning what specific skills should be trained, an empirical database is needed that demonstrates that "If team skill X is trained, the level of team performance that is achieved

is significantly more effective than when this team skill is not trained." Although it would be quite useful for team skill selection, such a database does not currently exist. However, some research suggests that training specific team skills does facilitate more effective team performance. For example, Smith & Salas (1990) demonstrated the utility of training assertiveness skills to two-person teams performing a low fidelity flight simulation task. However, the findings of empirical studies are often equivocal (e.g., see discussion of team building studies below), and the scope of existing research is limited. Therefore, the available empirical data fall short of providing database on which to base solid recommendations.

Therefore, the appropriate selection of KSAs depends upon the establishment of methodologies that yield valid measurements of KSA importance. To date, there is a dearth of such methodologies, with the exception of the contributions made by Bowers and his colleagues (Bowers, Baker, & Salas, 1994; Bowers, Morgan, Salas, & Prince, 1993). These researchers have investigated the selection of KSAs in the context of aircrew coordination training. They have argued that although aircrew coordination, in general, is important for effective flight performance, specific aspects of coordination may be particularly critical to performance at certain phases of flight (Bowers, et al.,

1993). For example, dealing with an emergency engine failure is likely to depend more on effective crew communication and decision making than on leadership or assertiveness (Bowers, et al., 1993). By appropriately selecting the KSAs to be included in training, the utility of training interventions can be enhanced.

Bowers and his colleagues (Bowers, et al., 1993) developed a questionnaire to assess coordination demand, which they defined as "the extent to which a given flight task places a requirement (demand) for the crew to interact, cooperate, or coordinate their activities to accomplish the task" (p. 99). In this study, coordination was operationalized in terms of the behaviors included under the seven dimensions (i.e., communication, situational awareness, decision making, mission analysis, leadership, adaptation, and assertiveness) identified by Franz and his colleagues (Franz, et al., 1990), as described above. A Coordination Demand Questionnaire, which consisted of thirty-eight different tasks associated with military cargo helicopter flight, was administered to a sample of military pilots. These pilots rated each flight task on the extent to which it required execution of each component dimension of coordination. That is, pilots provided ratings for communication, situational awareness, etc., as well as a rating of overall coordination. The results of this study

indicated that the pilots' ratings were consistent with expert ratings, and reflected differences between routine and nonroutine task situations, hence, providing evidence of the validity of this particular methodology.

Although the assessment of coordination demand as demonstrated in the previous study represents one of the few methodologies available to select team skills for training, it yields only global ratings of the behavioral dimensions of coordination. In a follow-up study, Bowers and his colleagues (Bowers, et al., 1994) attempted to further improve upon the state of the art by providing a means to select specific skills to be included in training. These researchers compared the relative utility of five measures of task importance that are commonly employed in the assessment of individual tasks. More specifically, a list of team tasks was compiled for each of three different military aircraft (i.e., an attack aircraft, a fighter aircraft, and a cargo helicopter), based on the existing literature and subject matter expert ratings (see Franz, et al., 1990). Pilots rated these tasks, and the five indices of task importance were computed based on: 1) the combination of ratings of criticality of error, task difficulty, and relative time spent (Levine, 1983); 2) the combination of ratings of task criticality and difficulty of learning (Sanchez & Levine, 1989); 3) the combination of

task criticality and importance to train ratings; 4) ratings of relative time spent; and 5) an overall rating of task importance. The results of this study indicated that only task criticality and importance to train significantly predicted variance in ratings of overall importance. However, all five indices demonstrated low reliability (i.e., as computed across raters) and validity (i.e., as measured by comparing the relative convergence of each index with the overall importance rating per task for each of the three aircraft).

In light of the obtained results, Bowers and his colleagues (Bowers, et al., 1994) concur with Dyer's (1984) contention that methodologies employed with individuals have limited utility in the team arena. They conclude that further research is needed to develop an effective methodology for selecting which KSAs should be emphasized in team training. They specifically recommend that theidentification of alternative dimensions along which team tasks could be rated (i.e., in addition to task criticality, relative time spent, etc.), and the identification of additional criteria for determining teamwork effectiveness would represent useful contributions along these lines.

One issue that is relevant to the development of methodologies for selecting team KSAs should be included in the current discussion. This issue has been discussed

predominantly in the context of aircrew coordination skills training, and involves the level of fidelity, or realism, that must be incorporated into training scenarios. Many commercial and military carriers use simulations of flight to train aircrew coordination skills (Stout, Cannon-Bowers, Salas, & Morgan, 1990). The issue of concern in the current discussion of team skills selection involves the level of realism, or fidelity, that is necessary for simulations to elicit team skills. Most military and commercial organizations that use simulation as a way to train crew coordination employ full-mission simulation (Stout, et al., 1990). Depending upon full-mission simulation for aircrew coordination training is potentially disadvantageous in that simulation equipment and simulation time are often expensive and difficult to access.

Bowers and his colleagues (Bowers, Salas, Prince, & Brannick, 1992) suggest that full-mission simulation could be replaced with low-fidelity simulation for use in coordination training interventions. These researchers discuss several studies that have attempted to discern the potential utility of low fidelity simulation in the context of aircrew coordination (Brannick, Roach, & Salas, 1991; Lassiter, Vaughn, Smaltz, Morgan, & Salas, 1990; Smith & Salas, 1991; Stout, et al., 1990; Urban, Bowers, Franz, & Morgan, 1991). The study of Stout and her colleagues

(Stout, et al., 1990) specifically demonstrated that coordination behaviors were elicited from crews performing a low fidelity flight simulation. In one other study using low fidelity flight simulation, Urban and her colleagues (Urban, et al., 1991) demonstrated that frequency of coordination behaviors was positively related to crew performance.

Although future research is needed to further determine the extent to which low fidelity simulation can be appropriately applied to the training of operational team skills, the research available to date suggests that low fidelity simulation could be a useful paradigm in which to further develop techniques for the selection of team KSAs for training, given that these behaviors seem to be elicited during such simulations.

As was the case with the discussion of the identification of team skills, the current discussion has primarily focused on how to select team skills for training, rather than addressing what team skills should be selected for training. Discussion of the latter is more difficult, given the previously described shortcomings of the empirical knowledge available to date. However, it could be argued that the critical team skills that have been identified in prior research conducted to date, would also be likely candidates for inclusion in training. Again, those team

skills are: sequencing communicated information properly to insure team members have needed information, using proper terminology when communicating, asking for clarification when needed, double checking team members and providing peer critique, providing team mates with feedback in appropriate, non-threatening ways, and appropriately accepting constructive feedback.

Acquisition of Team KSAs

Once team skills have been selected for inclusion in a team training program, the program itself must be designed. This design is often built around some type of model or general approach. For example, the Navy's Aircrew Coordination Training (ACT) program employs a skills-based approach, in that the training program focuses on the extent to which team members engage in certain behaviors or skills. In addition to specifying the focus or target of training, the design of a training program also determines the organization or sequencing of the components of training. The following review attempts to describe the major design strategies that have been employed in the team arena.

The Instructional Systems Development (ISD) model has served as a general guide to a variety of team training approaches. The ISD model as developed by Goldstein (1976), delineates five major training step. These five steps are: analysis of tasks, design of objectives, development of

instructional method, planning and monitoring of instruction implementation, and evaluation of effectiveness. Various aspects of this model have been applied to team training. Swezey and his colleagues (Swezey, Llaneras, & Salas, 1990) contend that guidelines based upon the ISD model are often too general and have low prescriptive ability. However, some attempts have been made to use the ISD model as a guideline for the development of methods for team training.

One particular team training application of the ISD model has been developed by researchers in the nuclear power industry (Davis, et al., 1985; Davis, et al., 1986). This approach focuses on team skills and recommends the following five phases for the design of training programs: 1) identification and preparation of objectives, 2) training of basic team skills, 3) training of team tasks, 4) evaluation of team skills, and 5) evaluation of the team training program. These phases, which were based on a review of the available literature, as well as on the contributions made by attendees of the previously described Nuclear Regulatory Commission workshop, can be further delineated.

According to Davis and his colleagues (Davis, et al., 1986), the first step of identifying team skill objectives requires team trainers to identify generic team skills, to identify operational skills, and to prepare team skill objectives. Training of basic team skills (step two)

involves conducting familiarization training of generic team skills and conducting practice training of operational team skills. In order for team task training to occur (step three), team tasks must be selected for training, team task training scenarios must be developed, and then team task training can be conducted. Steps four (evaluation of team skills) and five (evaluation of team training program) are not further broken down into subcomponents. Davis and his colleagues (Davis, et al., 1986) do recommend the use of checklists and videotaping to assist in the evaluation of team skills demonstrated during training sessions. Internal (pre-tests and post-tests) and external (supervisor ratings) tests were suggested as means of training program evaluation.

A skills-based approach to training has been employed in the arena of aircrew coordination training (ACT) and cockpit resource management (CRM). According to Prince and her colleagues (Prince, et al. 1992), a skills-based approach to training attempts to delineate specific behaviors within more global skill dimensions. By first identifying specific behaviors, effective training of these behaviors can be achieved through such means as behavior modeling (e.g., Smith, 1990; 1994) or by giving feedback after periods of practice (e.g., Wilhelm, Helmreich, & Gregorich, 1989).

A great deal of research has been conducted in order to identify the behaviors around which aircrew training programs should be designed. As previously mentioned, Franz and his colleagues (Franz, et al., 1990) identified coordination behaviors and classified them into the following seven dimensions: communication, situational awareness, decision making, mission analysis, leadership, adaptation, and assertiveness. The specific behaviors encompassed by each of these categories constitute the specific skills essential to effective training in coordination for aircrews. Based on this work, a behavioral checklist was developed for evaluating aircrew coordination. The observation component of this Aircrew Coordination Observation/Evaluation (ACO/E) Scale allows observers to record the frequency of occurrence of specific coordination behaviors within each of the seven global dimensions. The evaluation component requires observers to subjectively rate pilot and copilot performance in terms of each of the seven dimensions of coordination. Empirical studies have demonstrated that both the behavioral frequencies (Urban, et al., 1990) and subjective ratings (Lassiter, et al., 1989; Stout, Cannon-Bowers, Salas, & Morgan, 1990) are predictive of effective performance. Hence, the ACO/E has become an important tool in the Navy's ACT program, used to give feedback in the training of operational aircrews.

An organizational development strategy employing team building as a means of team development has also received a significant amount of research attention (French & Bell, 1984; Liebowitz & DeMeuse, 1982; Tannenbaum, Beard, & Salas, 1992). Team building has been defined as a process intervention "...which is aimed at helping individuals and groups examine and act upon their behavior and relationships" (Tannenbaum, et al., 1992; p. 126). This differs from team training, which is focused on acquiring the knowledge, skills, and abilities required for effective team performance. According to Tannenbaum and his colleagues (Tannenbaum, et al., 1992), team building interventions can be classified into one of four types, depending upon which team feature represents the focus of the intervention. That is, team building employs either a goal setting approach, an interpersonal approach, a role approach, or a problem solving approach, or some combination of these.

The goal setting approach attempts to enhance effectiveness by setting specific levels of output to be obtained by the team, and/or by specifying levels of output to be obtained by individuals within the team. The interpersonal approach seeks to improve the relationships between/among team members, usually by reducing conflict among members or by attempting to evoke more positive

feelings about other team members and/or membership in the team as a whole. The role approach attempts to improve effectiveness by making clear the specific duties to be performed by each individual team member. With the problem solving approach, team members generally decide upon some plan for "fixing" a particular problem or situation brought to the team's attention through some (usually external) diagnostic procedure.

In a review performed by Sundstrom and his colleagues (Sundstrom, et al., 1990), thirteen studies were identified that had been conducted since 1980 that employed at least one of these team building interventions. The interpersonal approach was often combined with one of the other three strategies. For example, Eden (1985) combined the interpersonal intervention with goal setting and role definition in a study employing members of Israeli Defense Forces command teams. According to Tannenbaum and his colleagues (Tannenbaum, et al., 1992), over seventy-five percent of team building studies conducted in the 1980s employed more than one intervention. Unfortunately, however, these researchers also conclude that there is a general absence of an appropriate rationale for selecting one or more of the above intervention strategies for use in a given situation.

Furthermore, it has been noted that research regarding team building has improved compared to research conducted prior to the 1980s in experimental rigor (e.g., in using control groups) and through investigating different types of teams (e.g., project groups, production and service teams, etc.) (Sundstrom, et al., 1990; Tannenbaum, et al., 1992). Remaining methodological shortcomings make interpretation of the team building literature difficult. These issues, however, are addressed in detail in a subsequent discussion of evaluation of team training programs.

Although not ascribing to a particular model of training design (e.g., skills-based model, process-oriented model, etc.), Swezey and Salas (1992) provide specific guidelines to be used in the development of team training. These researchers inspected over two thousand documents in their search for learning and instructional guidelines. A guideline was defined as "'A brief statement that describes or suggests action(s) or condition(s) that, if correctly and appropriately applied, could be used to improve or facilitate either instructional or training device, design and development activity'" (Swezey & Salas, 1992, p. 223). From the available database, these researchers selected 150 articles that contained approximately 1,200 such guidelines.

Swezey & Salas (1992) encountered two particular problems in the selection of these guidelines. Namely,

redundancy existed across the available articles, and many of the guidelines were vague, and hence, rather non-prescriptive. These guidelines were reduced and interpreted by Swezey and Salas (1992). After this procedure, approximately 500 guidelines remained, 146 of which pertain to team process issues. While the guidelines are too numerous to be listed in the current review, those guidelines concerning team interaction processes referred to the following areas: team mission and goals; environment and operating situation; organization, size, and interaction; motivation, attitudes, and cohesion; leadership; communication; adaptability; knowledge and skills development; coordination and cooperation; evaluation; team training situation; and assessment.

Another important issue in training design involves the distinction between part-task and whole-task training. In the context of teams, this distinction can translate to the difference between training team members individually or training the team as a whole. The distinction between part-task and whole-task training can also apply to the content of training. That is, team members can be trained on the tasks that must be performed individually, or they can be trained on the interpersonal aspects of the team task that allow them to interact with each other. Putting these two part-task versus whole-task distinctions together, there are

four possible combinations of training: individual-individual task training, individual-team task training, team-individual task training, team-team task training (Salas et al., 1992). Similarly, the feedback that team members receive about their performance is an essential element of training, and the same four distinctions as described above can be made concerning the part-task versus whole-task nature of providing feedback. Although much more research is needed to make recommendations concerning these aspects of part-task versus whole-task training in teams (Salas, et al., 1992), the following discussion attempts to review the literature that is currently available.

The literature available prior to the period of the current review provides some insight into the issue of training individual versus training team skills. For example, the results of several studies support the recommendation that team skill training should occur after team members have been trained regarding individual skills (Briggs & Johnston, 1967; Johnston, 1966; Klaus & Glaser, 1970). However, very little research has been conducted more recently that directly investigates when team versus individual skills should be trained.

Morgan and his colleagues investigated the effects of team training load on individual and team performance (Morgan, Coates, Kirby, & Alluisi, 1984). In this study,

five-person teams were trained in the performance of several individual and one team task. After teams had achieved asymptotic performance on both the individual and team tasks, trained team members were combined with untrained members to induce varying team training loads. One untrained team member in a five person team induced a twenty percent team training load. Two untrained team members induced a forty percent team training load, etc. In this experiment, team training loads of zero, twenty, forty, sixty, eighty, and one hundred percent were induced. Obtained decrements in both individual and team performance demonstrated an additive effect of the number of untrained team members. However, the rate at which the untrained team members improved was not influenced by team training load, nor was the individual performance of trained team members. Morgan and his colleagues (Morgan, et al., 1984) conclude that, because team training load did not slow skill acquisition rates, members of operational teams could be trained collectively. However, further research is necessary in order to further generalize these results.

Recently, some research has been performed concerning the provision of feedback in team training. Weaver and her colleagues (Weaver, Urban, Maniam, & Bowers, 1994) provided either feedback on team task performance only, or feedback on both team and individual task performance, to five person

teams performing individual tasks in conjunction with a team task. The results of this study indicated that teams who received feedback concerning only team task performance performed significantly better on this task than teams who received both individual and team task feedback. However, when team task performance was analyzed over trials, the decrement associated with individual task feedback appeared only in the initial trials of performance. At asymptotic performance, significant differences in team task performance were not observed across levels of feedback. With respect to individual task performance, the inclusion of individual task feedback enhanced this aspect of performance. However, the effect of the type of feedback provided did interact with the team structure. That is, the inclusion of individual task feedback seemed to degrade the performance of non-hierarchically arranged teams, but not that of hierarchically structured teams.

Feedback was also investigated in a study conducted by Jentsch and his colleagues (Jentsch et al., 1994). Again, the feedback that was provided to team members was manipulated, but subjects in this experiment were only required to perform one task (i.e., a team tracking task). Subjects were either given no feedback, individual feedback (i.e., feedback concerning one's own tracking error), or team feedback (i.e., team score, which was the algebraic sum

of both team members' tracking error). The results of this study indicated that the best performance was associated with the provision of individual feedback. Jentsch and his colleagues (Jentsch, et al., 1994) conclude that the effectiveness of feedback depends upon the extent to which it provides information concerning one's contribution to the team task. The obtained results also indicate that team members focus on that aspect of a task for which they are given feedback, thus concurring with the results obtained by Weaver and her colleagues (Weaver, et al., 1994).

Clearly, additional research is necessary to further elucidate the role that feedback plays in team training. This work must focus on the content of feedback (i.e., feedback concerning individual versus team aspects of performance), as well as to whom feedback is provided (i.e., the individual or the team). The empirical work that has been conducted to date verifies the complex nature of feedback in team training. The research of Weaver and her colleagues (Weaver, et al., 1994) in particular, which demonstrates the potential of feedback to adversely influence performance, demonstrates the importance of obtaining a better understanding of the effects of feedback.

In summary, since the time of Dyer's (1984) review, a great deal of progress has been made concerning the design of team training programs. Specifically, because teams are

required to perform in a wide variety of contemporary work settings, many different models of training design have been developed. Of these models, much research has been conducted to test the utility of the skills-based and team building approaches, although the data concerning the latter are rather equivocal. Furthermore, it has been argued that the ISD model suffers from being to general and having low prescriptive ability (Swezey et al., 1990). Concerning the state of the art knowledge of the sequencing of components of training, little progress has been made since the time of Dyer's (1984) review. However, some recent work on feedback concurs that team members focus on the aspect of the task for which they are given feedback (Jentsch et al., 1994; Weaver et al., 1994).

The Evaluation of Team Training Programs

Current understanding of team training evaluation is rather limited. Although evaluation guidance is often given in connection with specific training recommendations (e.g., skills based training approach of Davis and his colleagues (Davis, et al., 1986)), this guidance is typically quite brief.

However, the requirements for the appropriate evaluation of the Navy's skills-based aircrew coordination training program are delineated in detail by Cannon-Bowers and her colleagues (Cannon-Bowers, Prince, Salas, Owens,

Morgan, & Gonos, 1989). This evaluation is multi-faceted in that it consists of five stages which are based upon Kirkpatrick's Evaluation Hierarchy (Kirkpatrick, 1976). These five stages are: pre-training assessment, reaction to training, learning, performance assessment, and mission effectiveness.

Pre-training assessment refers to obtaining a base-line measure assessing those aspects of behavior that represent the target of the training program. By obtaining such an assessment, a post-test administered after completion of training can be used to determine the extent to which the training program was effective. Reaction to training refers to getting insight from trainees (after training is completed) concerning the extent to which they believed the training program to be useful. According to Cannon-Bowers and her colleagues (Cannon-Bowers, et al., 1989), these reactions can provide essential information concerning shortcomings of the training program, as well as trainee motivation. In the learning phase of program evaluation, assessment focuses on the extent to which team members' knowledge was enhanced concerning those areas in which enhancement was desired. Cannon-Bowers and her colleagues (Cannon-Bowers, et al., 1989) describes that these areas are delineated in the front-end knowledge objectives of the training needs analysis. These researchers also include

measurement of coordination attitude change as an important index of learning in aircrews. The performance assessment phase of program evaluation refers to assessing the extent to which the desired changes in team members' behaviors, knowledge, skills, etc., that were targeted by the training program, actually occurred. Mission effectiveness refers to the extent to which the training program has, over time, the desired effect on the larger organization. In the context of aircrews, mission effectiveness is defined as a reduction in the occurrence of aviation accidents.

While this skills-based training program evaluation has received some attention by researchers, additional work is needed to evaluate training programs employing a team building approach. It has been noted in the prior reviews of team building (Sundstrom, et al., 1990; Tannenbaum, et al., 1992) that a bias toward positive results remains because studies that demonstrate results are more likely to be published. However, all results have not been positive, particularly concerning changes in team members' behaviors. That is, team building interventions generally tend to be most effective in improving member attitudes and perceptions. In order for the effectiveness of team building programs to be properly evaluated, the multi-dimensional nature of team output needs to be further addressed (Kaplan, 1979; Tannenbaum, et al., 1992). That

is, what constitutes "effectiveness" must be delineated, and the utility of team building interventions assessed against this specific criterion. Furthermore, it is argued that evaluation of team building interventions could be improved by using objective measures in addition to subjective measures, as well as employing a pre-post non-equivalent control group design if true field experiments are not feasible (Tannenbaum, et al., 1992).

Finally, Liebowitz and DeMeuse (1982) provide specific, practical recommendations for the improvement of team building interventions. These recommendations are: 1) work tasks of interest must require coordinated action on the part of team members, 2) both hard (objective) and soft (subjective) criteria should be used as indicants of change, 3) outcome benefits of the program should be realistic, 4) commitment on the part of participants is required to assure long lasting improvements, 5) upper "management" support must be present, 6) formal team leaders must be open and willing to undergo attitudinal and behavioral change as well, 7) team members should be motivated to attend, as coercion might hinder positive results, and 8) a systems point of view should be adopted.

In addition to providing guidelines for the design of training programs, Swezey and Salas (1992) also provided general guidelines for the evaluation of training programs.

These guidelines, which were based on a review and synthesis of numerous studies (see Swezey & Salas, 1992), are listed below:

- An effective means of evaluation involves formalization and standardization of task-related and team-related feedback throughout training.
- Assessment methods should determine whether program objectives were met.
- A main objective of evaluation is to assess team needs and performance, and make the appropriate adjustment, throughout training.
- Evaluation instruments should be used to assess the validity of the training program content.
- The assessment process should help determine the impact of the training program on individual trainees in terms of knowledge, skills, performance, and attitudes. Such an evaluation should investigate the extent to which training affects performance in the operational environment.
- Assessment instruments should assess the impact of the training program on the overall mission effectiveness.
- Final assessment should provide feedback to improve the training program (Swezey & Salas, 1992, pp. 241-2).

Remediation

After team KSAs have been trained, the length of time for which training continues to exert its effects must be determined. Once training has "worn off", remediation or refresher team training must be administered. In the available literature, information concerning recurrent team training is sparse. In the context of CRM training for commercial pilots, the Federal Aviation Administration recommends a three stage model of training: awareness-feedback-reinforcement. The awareness phase consists of training crew members in the basic importance of CRM. The feedback stage consists of skills-based training and feedback (see previous discussion of the skills-based approach to training). The reinforcement phase consists of a CRM refresher that can occur as often as every six months (Prince, et al., 1992). According to Prince and her colleagues (Prince, et al., 1992), remediation training usually consists of a presentation (either videotaped or live) of some component of CRM.

It is hypothesized that the lack of sufficient treatment of remediation stems from two shortcomings in the available literature. First, longitudinal team performance data, in general, are lacking, as are data concerning the decay of training over time. Secondly, as previously described, the available knowledge concerning training evaluation is

limited. Clearly, if it is difficult to assess the utility of training immediately after it occurs, it becomes increasingly difficult to determine how its effectiveness changes over time.

Conclusions

Two specific questions represented the impetus of the current discussion: 1) what are team skills and what team skills should be trained, and 2) how can training programs be designed and evaluated to effectively train these skills? Answers to these questions were further subdivided into the following five areas: 1) KSA identification, 2) KSA selection, 3) KSA acquisition (i.e., training design and sequencing), 4) training evaluation, and 5) remediation.

This review indicates that, generally, a great deal of progress has been made in a variety of areas. Particularly, progress has been made in the development of methodologies to identify team skills. Of the approaches that have been reviewed, the MAP system, which classifies team training situations along three dimensions (level of analysis, training content, and developmental level) appears particularly promising in that it provides task analysis recommendations that are tailored for the situation. Based on a consensus of research conducted to date, the following team skills have been commonly identified as important targets of team training: sequencing communicated

information properly to insure team members have needed information, using proper terminology when communicating, asking for clarification when needed, double checking team members and providing peer critique, providing team mates with feedback in appropriate, non-threatening ways, and appropriately accepting constructive feedback.

Concerning the selection of team skills, progress has been made with respect to the development of methodologies for selection. However, those team skills that are currently likely candidates to be selected for inclusion in training are also those that have been identified above as "critical" team skills. Although new methodologies have been employed, much more work is needed to empirically assess the reliability and validity of these techniques for team skill identification and selection.

With respect to team KSA acquisition, several different models are currently being employed as the foundation for the design of team training programs. More progress must be made to enhance evaluation techniques, in order to determine the relative strengths and weaknesses of the various design approaches. Very little progress has been made concerning how training should be sequenced, given various part-task versus whole-task distinctions. Those studies that have been conducted illustrate the complexity of this problem, and verify the need for more work in this area. Finally,

data are scant concerning the need for remediation. This problem is exacerbated by the difficulties inherent in evaluating training program effectiveness.

As was the case with Dyer's (1984) review of the team training literature, the current discussion emphasizes the need for further empirical progress in the team training arena. Nevertheless, progress since 1984 has been made along a broad front in that reserach findings come from a diversity of operational areas. That is, team training issues are being investigated not only in the context of military teams, but also in the context of operational teams in settings such as nuclear control, management, commercial aviation, etc. Based on this integration of the research that has been performed since 1984, there is bright hope that future researchers will provide the depth of study necessary to generate an empirical database from which team training programs can be designed, implemented, and evaluated effectively.

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Table 1.

Team Definitions

Reference	Definition
Salas, Dickinson, Converse, & Tannenbaum (1992)	"[A] team is defined as a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span of membership." (p.4)
Sundstrom, De Meuse, & Futrell (1990)	"Work teams are defined as interdependent collections of individuals who share responsibility for specific outcomes for their organizations." (p.120)
Modrick (1986)	"A team is a functional unit of two or more people who must behave in a coordinated manner to perform some measurable work." (p.143)
McGrath (1984)	"Groups are those social aggregates that involve mutual awareness and potential mutual interaction." (p. 7)

Figure 1. Three-dimensional model of interdependence.